NEWTON'S
NAVIGATION

Colchester
Nov.r 7. 1767

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(very rare)

(inserted) 1695 altered to 1696

One of the Children Educated in xts Hospitall
Being the kings Royall gift & Foundation

AN IDEA OF Geography and Navigation.

CONTAINING

Easie Rules for finding the Latitude and difference of Longitude of Places by Observation of the Sun, Moon and Stars. The demonstration and use of the Log-line. The variation of the Compass. The Doctrine of Plain Triangles. The Construction and use of all manner of Mapps and Charts. To keep a Journal, and to work a Traverse both by Plain and *Mercators* Sayling. The Solution of all Nautical questions, Geometrically, Arithmetically, and Instrumentally.

ALSO

Tables of the Sun's Declina:ifion and Right Ascension for ever. A Table of the most Eminent fixed Stars in b:th Hemispheres, rectified for the Year 1700, with their use, and other Tables necessary in Navigation.

By SAMUEL NEWTON, *Master of the Math. School at* Christ's Hospital, *Founded by King* CHARLES II.

LONDON,
Printed for *Christopher Hussey*, at the *Flower-de-Luce* in *Little Britain*.
Sold likewise by *M. Marlo*, at King *Edwards*-Stairs in *Wapping*, by *W. Court*, at the *Mariner* and *Anchor* on *Tower-Hill*, by *B. Billingsly* and *R. Parker* under the *Piazza* of the *Royal Exchange*, and by *R. Cumberland*, at the *Angel* in St. *Paul's* Church-Yard. MLCXCVI.

To the Right Worshipfull

Sir *JOHN MOORE*, President,

NATHANIEL HAWS, Esq; Treasurer:

And to the Rest of the Worshipful Governors of

Christs-Hospital London.

THIS Manual containing the Principles of Geography and Navigation, which I composed for the use of my private School, without the least thought of ever making it publick, has at last

quitted its Retirement, and flies to your Worſhips for Protection. I muſt confeſs it is ſomewhat too early for its appearance abroad, becauſe I wanted time to give it thoſe finiſhing Strokes which might have rendred it pleaſant as well as uſeful. However ſeeing its method is plain and eaſie, it will be of uſe to me in the ſervice of Chriſts-Hoſpital, *and will ſave the Children of King* Charles *his Royal Mathematical Foundation, a great deal of time and pains in tranſcribing thoſe Rules contained in it. By your kind Reception of it, I am bold to*

think it will advance daily: And tho' it now appears in puris Naturalibus, *it may afterwards become far more Correct and Perfect. I am*

Your Worships

Christs-Hospital
June 28. 1695.

Most Faithful Servant

Samuel Newton.

TO

TO THE

READER.

THis Piece was Composed in so much haste, that as soon as I had finished the Composure of each Sheet, so much as I had composed was immediately hurry'd to the Press; and many times before I had deliberately consider'd it. So that I can no wayes excuse it from many Imperfections, nor affirm it to be so correct as I had at first designed it. As you will find (through my too much haste) in Page 90. where speaking concerning the way of discovering dif-

difference of Longitude by *Automatas*, it runs thus, *viz.* the farther you advance within the Artic or Antartic Circles, towards either of the Poles, the motion of the Clock ſhall be ſo much ſlower than at *Lond.* Nay the motion thereof ſhall be retarded tho' you encreaſe the Weight; and conſequently when theſe correct Automatas are carried into an Air more warm than that in which they were made, their motion ſhall be ſwifter than before. This Paragraph ought thus to be corrected; *that the farther you advance towards either Pole, their motion is ſwifter, and the farther they are carried towards the Equator, their motion is retarded:* I have little elſe to ſay to my Reader, for why ſhould I by a needleſs Addreſs to him anticipate his opinion of the whole Compoſure? But am apt to believe that he will find many things explained

with

with ſo much eaſe, and improved ſo exceedingly when compared with other Writers upon this Subject, that he will be forced to confeſs the Inſtructions here are uſeful, and adapted to the meaneſt Capacities; which was the Sole Aim of

S. Newton.

THE

THE
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To

ERRATA.

PAge 46. *l.* 2. all the three Angles given to find the sides, r. *all the three sides given to find the angle.* Page 184. *l.* 2. r. *the Ship in West Longitude.*

PROEM.

THAT *we may more clearly under ſtand this Art which concerns the motion of a Ship upon the Surface of the Sea, we ought to know the true Figure of this Terraqueous Maſs.*

Diverſe of the Antients ſuppoſed the Figure of our World to be a large extended Circular Plain, like that of a round Table, founded upon a Baſis or Pedeſtal, infinitely continued downwards.

Of this opinion was Lactantisu, *and others of the Primitive Fathers:* Anaximander *ſuppoſed it to be Cylindrical, like a Drum. But moſt Philoſophers and all Mathematicians in our dayes do affirm it Globular or Spherical.*

And that the Earth is Globular or Spherical they prove by theſe following Arguments:

1. *The Shadow of the Earth in every Lunar Eclipſe, projected to the Moon, appears Circular, which being granted, it neceſſarily follows, that the Earth from whence this Shadow proceeds, muſt be every way Circular, that is, Spherical.*

2. *When a Man moves directly North or South, the Pole of the World is elevated or depreſſed in the proportion, as the diſtance we move upon the Surfase of the Earth, (if Spherical) would require.*

Laſtly, *Where-ever we ſtand upon the Surface of the Earth or Sea, the Horizon does alwayes appear Circular.*

I pass by the Objection from the height of Mountains. For these Inequalities make as much against the Plane Figure of the Earth, as against the Spherical one, and are less then a drop of water could make upon a Table. For the Compass of the Earth is about 25000 English *Miles, and the greatest perpendicular height of Mountains, scarce above* 3 *Mile, so that Mountains are as nothing in Comparison of the whole Earth.*

'Tis true that the Earth and Sea seem plain to our sight, but this is because the Eye being elevated only a Man's height, or about 6 *feet above the Horizon, sees only such a small Portion of the Spherical surface of the Earth or Sea, as is contained in a Circle, whose Diameter is about six Miles, and so has no sensible Curvature. And when two Ships sail from one another, the Hulks disappear first by the convex Brow of the Water rising up as it were between them.*

To conclude, we have seen divers of our Age, have continued in an Easterly Course, till at last they have arrived without turning back, at the same place from whence the first set forth, which could not be, if the Earth were not of a Spherical Form. Lastly, we see the Heavens themselves and all the Cælestial Bodies, do all appear Spherical: Then seeing all these consistent parts of the Universe seem to be Orbicular, why should we fancy our Globe of different Form from the rest?

CHAP.

CHAP. I.

Of Astronomical and Geographical Definitions.

1. IF this Globe of Earth and Sea be circumscribed by a line drawn from No. to So. this line shall be a Circle, called the Meridian or No. and South line: for all those lines which can be drawn upon any Spherical or round Body must necessarily be round lines, called Circles.

2. If this Globe of Earth and Sea be circumscribed by another circular line at right angles to the Meridian, and equally distant from the No. and So. points of the Meridian, this line so drawn is called the Equator.

Thus in Figure 1. Let ABCE represent the Meridian line, drawn about the round World, so shall AOE represent the Equator.

3. If a right line be drawn through the Center of the Earth, and continued to the North or South points of the Meridian it is called the Axis of the World.

Thus in Fig. 1. Let B represent the North point, and C the South point of the Meridian, then if there be a right line drawn from B through the Center O, and continued to C, this line BOC is the Axis.

4. The ends of this Axis are called the Poles of the World; thus B is called the North Pole, and C the South Pole.

Note, all Meridians do meet at the Poles of the World: thus BFC. BGC. BHC. do all meet at the Poles B and C in Fig. 1.

5. That point in the Heavens which is directly over your head is called the Zenith, and that point which is directly under your feet is called the Nadir. Thus in Fig. 2. HÆZNPO. is the Meridian, NP. SP. the Axis of the World, NP the North Pole, SP the South Pole, Æ Æ the Equator, Z the Zenith, and N the Nadir.

6. Wheresoever you stand upon the Convex Superfices of the Earth or Sea, and looking round about, you see the Heavens and the Earth seem to meet, they make a Circle, in whose Center you stand, this Circle is called the Horizon, as in Fig. 2. HCO represents the Horizon, and the Center C, represents the Place where the Spectator stands.

Geographers for the clearer understanding of the Position of Places, have invented two terms of Art call'd Latitude and Longitude.

7. Latitude they say is an Arch of the Meridian contained between the Zenith and the Equator, or between the Pole and the Horizon. Thus in Fig. 2. if O represent the North point of the Horizon, and NP the North Pole of the world, the Arch of the Meridian contained between O and NP is called the Latitude of the Place, and it is always equal to ZÆ, the distance of the Zenith from the Equator.

8. Lon-

8. Longitude is an Arch of the Equator contained between the first Meridian and the Meridian of any other Place: Thus in Fig 1. let ABEC represent the Meridian of the Place propounded: I say the Meridian BIC cuts the Equator in G therefore the Arch of the Equator AG, shews the difference between the first Meridian ABEC and the Meridian of the Place propounded, *viz*. BIC.

Note, Geographers do sometimes (especially upon our Globes) draw the first Meridian over the Azores, because under that Meridian the Sea Compass has no variation or deflexion from the North or South points of the Horizon: But in Maps or Charts they sometimes draw the first Meridian over *Tenariff*, and sometimes over the Metropolis of that Country wherein they were borne: As English-men over *London*, Frenchmen, over *Paris*.

9. All that space of Earth contained between the Equator and the N°. Pole is said to lye in North Latitude: thus in Fig. 2. if the Zenith of any place lye between the Equator and the North Pole, it is said to lye in N°. Latitude. Thus Z the Zenith of the Place C falling between the Equator Æ, and the N°. Pole NP, shews the place at C lyes in N°. Latitude: and the number of Degrees contained between Æ and Z, or NP and O, shews the Degrees of its Latitude. Hence it follows that whereever the N°. Pole is above the Horizon, that place lyes in North Latitude.

10. All that space of Earth contain'd between the South Pole and the Equator, is said to lye in South Latitude, and consequently when the South

Pole is elevated above the Horizon, you are in South Latitude; thus alſo in Fig. 5. if the Zenith of any place lye between the South Pole and the Equator that place is ſaid to lye in South Latitude. Let the place be C, the Zenith thereof Z, falling between SP the South Pole, and Æ the Equator, ſhews the place to lye in South Latitude: and the number of Degrees contained between Z and Æ, or between SP and H ſhews the Degree of Latitude.

Note, Mathematicians divide the circumference of every Circle into 360 equal parts, called Degrees: each Degree into 60 equal parts, called minutes: each minute into 60 Seconds, *&c.* the reaſon why they choſe 360 before any other number, is becauſe this number contains more aliquot parts than any other, conſiſting of 3 Figures.

Hence then a Semicircle muſt contain 180 Degrees, and a Quadrant 90 Degrees: And from this note, and def. 9 and 10, you may obſerve that the Pole can never be elvated above the Horizon, more than a Quadrant, and conſequently the Latitude of places can never exceed 90 Degrees.

11. Difference of Latitude is an Arch of the Meridian, contained between any two given Latitudes. Thus in Fig. 1. if one place lye at K, the other at L, the arch KL is called the diff. Latitude between the two places.

12. Diff. Longitude is an arch of the Equator contained betwen the Meridians of any two places. Thus in Fig. 1. let the two given places be M and I: let BMC be the Meridian of the one, and BIC the Meridian of the other, theſe two Meridians

cut

cut the Equator at F and G; therefore the arch FG is called the diff. Longit. between the two places.

13. The Meridians Equator and Horizon are called Great Circles of the Sphere, becauſe they divide the World into two equal parts; and the Circles KMIN, LP, are called leſſer Circles, becauſe they do not divide the World into two equal, but into two unequal parts. Theſe Circles being leſs than the Equator, and parallel to it are called Parallels.

14. The Declination of the Sun, or any Star is the number of the degrees that the Sun or Star is diſtant from the Equinoctial. Then,

If the Sun or Star lye between the Equinoctial and the North Pole, the Declination thereof is called North: but if between the Equinoctial and the South Pole, the Declination thereof is ſaid to be South.

CHAP. II.

To find the Ships Latitude at Sea, by obſerving the Meridian Altitude of the Sun or Stars.

IN obſerving the Latitude at Sea, we muſt always have given the Sun or Stars Meridian Altitude and Declination: and muſt diligently

mark whither the Sun or Star be to the Northward, or to the Southward of the Zenith, which the Sea Compaſs always ſheweth.

The Meridian Altitude of Sun or Star is the Number of Degrees which the Sun or Star is diſtant from the Horizon upon the Meridian : and this number of Degrees ſubtracted from 90°. co' leaves the diſtance of the Sun or Star from the Zenith.

To conceive, the reaſon or various operations in Aſtronomical Obſervations, you muſt protract the ſame according to theſe following inſtructions, and then it will appear. That

1. If the Sun hath N°. Dec. the Equinoctial muſt be to the Southward of the Sun : and if the Sun hath S°. Dec. it muſt be placed to the Northward of the Sun.

2. If you find the N°. Pole in your Figure above the Horizon, you are in N°. Latitude : if the South Pole be above it, you are in South Latitude.

3. The N°. or S°. Pole is alwayes 90°. diſtant from the Horizon.

4. The Zenith is always ſo many Degrees diſtant from the Equinoctial as the N°. or S°. Pole is from the Horizon.

In the following Figures HZON repreſents the Meridian : Z, the Zenith, N the Nadir. HCO the Horizon. ÆÆ the Equinoctial. NP the N°. Pole. SP the S°. Pole. H the South point of the Horizon. O the N°. point thereof. A the Sun in N°. Dec. B the Sun in South Dec. HA, or HB the Sun's Meridian Altitude. ZA or ZB the Compt. thereof, or diſtance of the Sun from the Zenith.

Zenith. NPA the Compt. of the Sun's N°. Dec. SPB the Compt. of the Suns South Dec. ONP (alwayes equal to ZÆ) the Latitude or height of the Pole above the Horizon.

PROB. 1. Fig. 2.

The Sun or Star having no Declinat.

A Ship at Sea, March 10th. 1694. *observes the Sun upon the Meridian to the Southward of the Zenith* 50° 00′. *I demand her Latitude.*

Strike a Circle and Croſs with two Diameters HO. ZN at right angles through the Center C, then becauſe (in the Example) the Sun hath no Dec. and is to the Southward of the Zenith, ſet the Sun's Meridian Altitude from H to Æ: draw the Line ÆCÆ to repreſent the Equinoctial: then draw NP, SP at right angles to ÆCÆ. It is evident from the Figure that if the Sun (being in the Equinoctial) be upon the Meridian to the Southward of the Zenith, the N°. Pole muſt be to the Northward thereof: and by the third Rule of this Chap. muſt be 90 Degrees diſtant from the point Æ: therefore NP is the N°. Pole, and being elevated above the Horizon, ſhews the Ship to be in N°. Latitude. Therefore,

From HZ 90° 00′
Subtr. HÆ 50 00

Remains ÆZ 40 00. equal to NPO the Ship's N°. Latitude.

PROB.

PROB. 2. Fig. 3.

The Sun or Star being in the Zenith.

A Ship at Sea, June 10th 1694. *observes the Sun upon the Meridian in the Zenith. I demand her Latitude.*

By Rule 1. of this Chap. set the Sun's Dec. *viz.* 23°.30′ N°. from Z to Æ, and draw the Equinoctial ÆCÆ, and NPC, SP at right angles to it, then from Rule 4*th*. it is plain that ZÆ is equal to ONP, but ZÆ is 23°. 30′ therefore the Latitude ONP is 23°. 30′ and because NP is above the Horizon, therefore the Latitude is N°.

PROB. 3. Fig. 4.

The Sun or Star having N°. Dec. and upon the Meridian to the Southward.

A Ship at Sea, May 13. 1694. *observes the Sun upon the Meridian to the Southward* 58°. *high. I demand her Latitude.*

Set the Sun's Meridian Altitude from H to A, and the Sun's Declinat. by Rule 1. from A to Æ, draw ÆCÆ for the Equinoctial, and NPC. SP at right angles to it: then because the Sun's Declinat. is North, he must be nearer to the N°. Pole, *viz.* NP, than he is to the South Pole, *viz.* SP therefore

To

To the Sun's Co. Altitude ZA 32° 00'
Add the Sun's Dec. North AÆ——20 51

The Sum is ZÆ ———————— -52 51
equal to NPO the Ship's N°. Latitude.

PROB. 4. Fig. 4.

The Sun having South Declination, and upon the Meridian to the Southward.

A Ship at Sea, Dec. 10th. 1694. *observes the Sun upon the Meridian to the Southward* 21°. *high. I demand her Latitude.*

Set the Sun's Meridian Altitude from H to B, and by Rule 1. his Dec. 23°. 30' South from B to Æ, draw the Line Æ Æ, and NP. SP at right angles to it, so shall NP, or the North Pole be above the Horizon. Therefore,

From the Sun's Co. Altitude BZ 79° 00'
Subtr. Sun's S°. Dec. BÆ ———23 30

The Remainer is ÆZ ————— 55 30
equal to ONP the Ship's Latitude N°.

PROB 5. Fig. 5.

The Sun having N°. Dec. and upon the Meridian to the Northward.

A Ship at Sea, May 13. *observes the Sun upon the Meridian to the Northward of her Zenith* 58°. *high. I demand her Latitude.*

Set the Sun's Meridian Altitude from O to A, and by Rule 1. of this Chap. his Dec. from A to

Æ draw

Æ draw ÆÆ, and NP. SP at right angles to it, ſo ſhall SP be above the Horizon ; therefore by Rule 2d. of this Chapter, the Ship is in South Latitude.

From the Co. Altit. Z A	32°	00′
Subtr. the Sun's Dec. N°. ÆA	20	51
The Remainer is ZÆ	11	09 equal

to HSP the Ship's South Latitude.

PROB. 6. Fig. 6.

The Sun having South Dec. and upon the Meridian to the Northward, near the Horizon.

A Ship at Sea, Dec. 10th. 1694. *obſerves the Sun upon the Meridian to the Northward* 12°. *high. I Demand her Latitude.*

Set the Sun's Altitude from O to B, and by Rule 1. of this Chap. his Dec. from B to Æ ; draw ÆÆ and NP. SP at right angl s to it : ſo ſhall SP be above the Horizon. Therefore,

To the Sun's Co. Dec. SPB	66°	30′
Add his Merid. Altit. OB	12	00
The ſum is SPO ————	78	30 equal

to Z Æ the Ships South Latitude.

PROB.

PROB. 7. Fig. 7.

The Sun having South Dec. and upon the Meridian to the Southward, near the Zenith.

A Ship at Sea, Dec. 12. 1694. *observes the Sun upon the Merid. to the Southward* 78°. *high. I demand her Latitude.*

Set the Sun's Altitude from H to B, and by Rule 1. his Dec. from B to Æ, draw ÆÆ, and NP. SP at right angles to it, so shall SP (or the South Pole) be above the Horizon. Therefore,

From the Sun's S°. Dec BÆ	23°	30′
Subtr. his Co. Altit. BZ —	12	00
Remainer is ZÆ —— ——	11	30

equal to SPH the Ship's South Latitude.

PROB. 8. Fig. 4.

To find the Ship's Latitude by the Stars.

A Ship at Sea, observes Lyra upon the Meridian to the Southward 58°. *high. I demand her Latitude.*

Set the Meridian Altitude from H to A, and because this Star hath N°. Dec. set its Dec. from A to Æ, draw ÆCÆ, and NP. SP at right angles to it: then it is evident the Ship is in North Latitude. Therefore as in Prob. 3.

To the Star's Co. Altitude ZA	32°	00′
Add the * North Decl. AÆ	38	32
The summ is ZÆ —— ——	50	32

equal

equal to NPO the Ship's N°. Latitude required.

Hence it appears that all obſervations of the Ships Latitude at Sea, taken by the Sun or Stars, are to be wrought by the ſame rules.

PROB. 9. Fig. 4.

Having the Latitude of any place given, to find the Sun's Meridian Altitude in that place, for any day in the Year.

The Latitude of Lond. *being* 51°. 32′ *N°. I demand the Sun's Meridian Altitude there, upon the* 10th *of* June.

Set the Latitude from O to NP, and draw NP. SP, and ÆCÆ at right angles to it; then ſet the Sun's Dec. for *June* 10*th.* viz. 23°. 30′ North from Æ to A, ſo ſhall H A be the Sun's Meridian Altitude required, Therefore,

To Co. Latitude H Æ	38°	28′
Add the Sun's N° Dec. ÆA	23	30
Sum is H A ————	61	58

The Sun's Meridian Altitude for the day required at *Lond.*

And thus alſo may you find the Meridian Altitude of any Star, in any place whoſe Latitude is known.

CHAP.

CHAP. III. Fig. 8

Concerning the Quantity of a Degree in a great Circle, upon the Circumference of the Earth.

THE most acute Wits in former Ages have spent much pains in the inquiry after this useful piece of knowledge; else so many Excellent Volumes wrote upon this Subject had not been handed down to Posterity: *Diogenes Laertius* commends *Anaximander*, because he first took this Subject to task, and as Historians tell us, *Anaximander* lived 55? years before the birth of our Saviour: *Eratosthenes* succeeded *Anaximander*, and lived about 200 years before Christ: But the methods he used for the solution of this Proposition, injurious time has deprived us of. *Posidonius* appeared next, who lived some few years before the Incarnation. These excellent Men did industriously endeavour the solution of this Prop. but brought it not to that degree of perfection which succeeding Ages attained to. And from that time to this present Generation we meet with none excepting some *Arabians* and *Saracens* have endeavoured the improvement of it. And in this Century we find the learned *Snellius*, Mathematical Professor at *Leyden*, enquiring into the practice of the Ancients

Ancients concerning the Quantity of a Degree in a Great Circle upon the Circumference of the Earth; he suspecting their performance, with incredible Industry undertook to determine the Quantity of a Degree, and affirms a Degree contains 28500 Perches, each Perch containing 12 Rinland feet: but a Rinland foot exceeds the English foot by .033, supposing an English foot divisible into 1000 equal parts. Therefore 28500 X 12 produceth 342000 Rinland feet, which multiplyed by 1.033 produceth 353286 English feet, for the Quantity of a Degree required. This proportion between a Rinland and an English foot, I find in Sir *Jonas Moor*'s Fortification and others. But Mr. *Norwood* in his Seaman's Practice, Pag. 34. tells you 96 Rinland Feet make 91 $\frac{1}{6}$ English feet which by this Proportion in Sir *Jonas Moor*'s should be made 99. $\frac{168}{1000}$, English feet but upon examining Mr. *Norwood*s following Proportions I find this 91 $\frac{1}{6}$ should be 99. 168 and that the fault lyes in the Printer, not in that Industrous Author.

After *Snellius* we meet with *Tacquet*, who delivers his Opinion of *Snellius*'s Experiment in these words: *Geom. Prac. Lib.* 1. *Cap.* 4. *Prob.* 4. *Cæterùm Snellii ista Dimensio non admodum probabilis est, quod ex nimis multis operationibus sit composita, quarum errores singularum simul juncti errorem magnum possunt efficere.* In the next place we find *Ricciolus*, a learned Jesuit, who neither sparing for Money nor time, made the Experiment, and found that a Degree did contain 72 $\frac{1}{4}$ *Bononian* Miles; but a *Bononian* Mile contains 5000 *Bononian* Feet, each *Bononian* Foot containing 1204 parts,

1000

1000 whereof make an English foot; therefore 72¼ multiplied by 5000, produceth 361250 *Bononian* feet, which multiplied by 1204 produceth 434945000, this divided by 1000, the Quotient is 434945 English feet in a deg. which divided by 5280 the English feet in a mile, gives 82. 375 English miles in one degree.

Lastly, Our Country man Mr. *Richard Norwood* made an experiment to this purpose, and found the quantity of a degree of a great Circle upon the surface of the Earth to be 367200 English feet, which is much different from that of *Ricciolus*; and seeing such experiments are not fit to be undertaken at the charge of a private man's fortune, as Mr. *Norwood* intimates; we may conclude that *Ricciolus* his experiment made at the expence of the Jesuits Purse, (he being a member of that Society) was far more exact and certain.

Thus I have given you a brief account of those Famous Men in several Ages, who attempted the discovery of a truth so useful to mankind, I shall now shew you the method some of them made use of, for the performance of it.

FIG. 8.

They first pitched upon two places, both under one Meridian, represented in the Heavens by the Circle BEAFDM, and on the Earth by the Circle GHIKL: the two places we will suppose to be H and I: then by the foregoing Chap. or else by the Circumpolar Stars (far more convenient for the present purpose) they found the

Latitude, or Poles height at both theſe places, which from the Figure may be eaſily conceiv'd; thus BCD will be the Horizon of the place at H, and BN may repreſent the height of the Pole there: and ECM the Horizon of the place at I, ſo ſhall EN repreſent the Latitude of the place I, and N ſhall be the North Pole. Then with all poſſible exactneſs they meaſured the diſtance of theſe two places, *viz.* the Arch HI, and by ſubtracting the leſſer Latitude EN, out of the greater BN, the remainer is BE their diff. Latitude: then becauſe BA, and EF are both Quadrants, therefore BE ſhall be equal to AF; thus the two Arches AF, in the Heavens, and its reſponding Arch HI on the Earth are both known: for by meaſure the Arch HI was found to contain 121. $\frac{704}{1000}$ miles, and the diff. Latit. or reſponding Arch in the Heavens, *viz.* AF was 1°. 45'. and theſe two Arches AF. HI are like by 33. 6. Euc. therefore, as 1°. 45'. is to 121. 704 miles, ſo is 360 (the degrees in the circumference of any Circle) to 25036. $\frac{36}{100}$ miles in the Ambit or Circumference of the Earth, which divided by 360 gives 69. $\frac{548}{1000}$ Engliſh miles for the quantity of a degree required.

And thus did Mr. *Norwood* proceed, for firſt he pitched upon the two famous Cities of this Country, *London* and *York*, and having found as afore the true diff. Latitude between them, he meaſured their diſtance aſunder, and then by the foregoing proportion diſcovered the quantity of a degree; only in meaſuring between them he did not confine himſelf to the Meridian, but deviated Eaſtward or Weſtward, as occaſion offered;

ed; and ſo by keeping an account in form of a Ships traverſe, he found the Meridional diſtance between the two places.

F I G. 9.

Eratoſthenes his method was this, he firſt aſſumed two places lying under the ſame Meridian, the one was *Alexandria* in *Egypt*, where he liv'd, the other was *Syene*, a City lying under the Tropick of Cancer, and conſequently by Chap. 2. the Latitude thereof was 23°. 30′. North. Hence alſo by Prob. 2. of Chap. 2. when the Sun came to the firſt point of Cancer, or (which is all one) when the Declinat. was 23°. 30′ N°. which happened upon *June* 17*th* or 18*th*. then he muſt be in the Zenith of that place, and his Altitude muſt be 90°. 00′. therefore he took the Sun's Meridian Altitude *June* 18*th* at *Alexandria*, and by Chap. 2. found the Latitude thereof to be 30°. 58′. N°. and conſequently the diff. Latit. between theſe two places to be 7°. 28′. and thus the Celeſtial Arch contain'd between the Zenith of theſe two places was diſcovered: next he meaſured the diſtance between them upon the Earth, carefully obſerving not to deviate from the Meridian under which the two places lay: and thus he found the reſponding Terreſtrial Arch, and then proceded as afore.

But the moſt remarkable circumſtance in this Experiment was his method of finding the Sun's Altitude upon the Meridian at theſe two places, which he did by a Concave Hemiſphere with a ſtyle erected perpendicular from the concave Nadir point, as CD, upon which the Sun ſhining from

 A, the

A, the Ray ECF determined the Meridian Altitude thereof, as GE or HF; and at the ſame time he found the Co-altitude, or diſtance of the Sun from the Zenith BE or FD, but at *Syene* the ſame day, the Sun could make no ſhadow, becauſe he was in the Zenith therefore he concluded that BE was the true Zenith's diſtance or diff. Latit. between theſe two places, *&c.*

Poſidonius his method was this, Fig. 8.

He aſſum'd two places under the ſame Meridian, as A repreſenting *Rhodes* where he lived, and F *Alexandria* in *Egypt*. In theſe two places he obſerved *Canobus* (or the bright Star in the Stern of the Ship) upon the Meridian, and whether this obſervation be made upon the ſame, or upon different days, it matters not. But this Star was not ſeen above, but only in the Horizon BKD at *Rhodes*, and at *Alexandria* the Meridian Altitude thereof above the Horizon ECM was found to be MD, or 7°. 30'. which is exactly the 48*th* part of 360 degrees; then he meaſured the reſponding Terreſtrial Arch LK, and ſo proceeded as afore.

The excellent *Varenius*, and others give you an account of divers other ways for finding the quantity of a degree upon the Earth, without the help of Aſtronomical Obſervations; but moſt of theſe being tranſlated into Engliſh, I refer the Reader to them, rather than ſpend more time in tranſcribing of them.

CHAP.

CHAP. IV.

Of the Log-Line.

DIvers ways have been invented for finding the Ship's motion at Sea; but the moſt uſual way is by the Log-line.

It is taken for granted amongſt our Engliſh Mariners that when this Log is caſt over board, (with ſufficient allowance for ſtray-line,) it remains quieſcent upon the ſurface of the Sea: the line to which the Log is made faſt, they uſually divide into certain equal ſpaces called knots, each 42 foot diſtant from other: and then by help of a Glaſs, which ought to contain $\frac{1}{2}$ a minute, they find how many knots the ſhip runs away from the Log in that quantity of time: and then they conclude, that if the Ship runs out one knot in $\frac{1}{2}$ a minute, ſhe runs one mile each hour: and 60 of theſe miles they ſuppoſe to be a Degree upon the ſurface of the Earth or Sea. But before we take this ſuppoſition to be true, let us examin it by the rule of reaſon, whether or no it will endure the Teſt.

Seeing the Ship's motion depends altogether upon the truth of the $\frac{1}{2}$ minute Glaſs, we will enquire the way how to find the quantity of an $\frac{1}{2}$ minute, which being repeated as often as you pleaſe, will ſtill produce the ſame.

The fixed Stars move more regularly than any of the Superiour Bodies, and their Equatorial motion is 1. degree for every 4 minutes in time: therefore if we find any two Stars whose difference in right ascension is 30. the Center of one of these Stars being upon the Meridian, the Center of the other shall come upon the same Meridian in ½ a minute's time after the other. As thus, if the little Star in the Eduction of the Crane's Tayle (whose right ascension for the year 1700) is 33 6°. be upon the Meridian, the Southern of the two in the Breast of Pegasus, (whose right ascension for the same year is 338) shall come upon the same Meridian 8 minutes after. Therefore their Equatorial distance in time, being 8 minutes, we are to find some particular method for measuring this or any other quantity of time, which is most exactly done by the Vibrations of a Pendulum, which may be demonstrated to be Equitemporal.

Experience confirms this Truth, that if there be a Pendulum whose length (from the Center) is 39. 2 inches, it vibrates Seconds, or sixty times in a minute; therefore for the tryal of your ½ minute Glasses, set one of these Pendulums in motion, and at the same time turn the Glass; and if the Glass be true, the Pendulum shall vibrate or cross the Perpendicular just 30 times before the Glass be run out: but most of those Glasses now us'd by our Seamen, seldom contain more than 25, or 26 Seconds: hence it is evident, their Glasses do not contain a true ½ minute.

And if you would find the quantity of time measured

measur'd by any other Pendulum whose length is greater or lesser than 39. 2 Inches, this is.

The Rule.

The length of Pendulums are to each other reciprocally as the Squares of their vibrations in the same time.

Thus, if a Pendulum 39. 2 inches long, vibrate, or cross the Perpendicular 60 times in a minute, how oft will a Pendulum 15. 5 inches vibrate in the same quantity of time. Say if 15. 5 inches, require 39. 2 inches, what shall 3600 (the square of 60 Seconds) require. Answer, the fourth proportional number is 9104, whose square root 95 gives the number of vibrations or swings that Pendulum shall make in one minute.

The demonstration whereof you may see more at large in *Kercher's Mundus Subterran. Ricciolus, Galileo*, and Mr. *Molineux* in his *Scioth. Telescopic.*

Thus it is evident the common ½ minute Glasses are false: we will next enquire into the Division of the Log-line, where each knot is 42 foot distant from other.

An English mile contains 8 Furlongs, each Furlong 11 Scores, and every Score 20 yards. So that a Statute mile contains 1760 yards, or 5280 English feet. Then seeing there are 120 half minutes in an hour, there ought to be 120 times 42 feet in a mile: but 120 multiplied by 42 produceth only 5040 feet, so that by this computation, they make only 5040 feet in a mile, which is 240 feet shorter than it ought to be: thus it appears that not 42, but 44 feet answer to the 120th part of an English mile: and conse-

 sequently

ſequently, both the common Glaſs and Diviſions upon the Line are erroneous.

And becauſe our Seamen are not eaſily perſwaded to leave any old cuſtom; we will continue the ſame Glaſs and diviſion of the Log-line, and yet find the Ship's true motion thereby.

For the performance whereof you muſt examine the quantity of your $\frac{1}{2}$ minute Glaſs, by a Pendulum of 39. 2 inches long: the weight appended being about one pound, and if you find this Glaſs to contian 25,26, or any other number of Seconds. Say,

If 25 Seconds require 42 feet, what ſhall 3600 Seconds require? Anſwer 6040 feet. Again,

If 26 (or any other number of Seconds) require 42 feet, what ſhall 3600 (the Seconds in an hour) require? Anſwer 5815 feet: hence it appears that the ſhorter the Glaſs, the longer is the Ship's diſtance: and the contrary; thus if the Glaſs contain 30 Seconds, the Ship's diſtance run will be 5040 feet each hour.

To apply this to our preſent purpoſe, I told you in the foregoing Chapter, that a Degree in a great Circle (upon the ſurface of the Earth) did contain (by Mr. *Norwood*'s Experiment) 69. 548 miles, or 367200 Engliſh feet: and ſeeing our Seamen do uſually divide a Degree into 60 equal parts, called miles, or minutes, every of theſe parts muſt be greater than an Engliſh mile: therefore if you divide 367200 by 60, the Quotient 6120 will be the number of Engliſh feet contained in one of theſe Sexagenary miles. Then if the Glaſs contain 25 Seconds, and the diſtance between any 2 knots be 42 foot; it is evident that if the

the Ship runs away from the Log-board 42 foot in 25 Seconds of time, ſhe muſt run 6040 foot in 3600 Seconds or one hour's time, that is the Ship muſt run $\frac{6040}{6120}$ of a mile, 60 whereof make a Degree. But this vulgar Fraction may be reduced into a Decimal Fraction, by this following Proportion, *viz.*

If 6120 require 1000, what ſhall 6040 require? Anſwer, 986, which being the Decimal parts of a mile which the Ship is ſuppos'd to move in one hour, when the Glaſs contains 25 Seconds; we may make a Table to ſhew by inſpection the number of miles run by the Ship, for any number of knots, *viz.* by the continual addition of 986, or by multiplying it by all the 9 Digits.

And becauſe all Glaſſes are not of a like content, and that every Seaman is not acquainted with Decimal Arithmetick, I have here added theſe following Tables.

TABLES

Tables for finding the Ship's true motion at Sea, by the Log kno's being 42 feet aſunder, for all Glaſſes from 23 Seconds to 30 Seconds

Glaſs 23 Seconds.				Glaſs 24 Seconds.			
Knots	Miles & 1000 parts.	ratio.	1000 pts of a mile	Knots	Miles & 1000 parts	ratio.	100 pts of 1 mile
1	1. 074	1	107	1	1. 029	1	103
2	2. 148	2	214	2	2. 058	2	206
3	3. 222	3	322	3	3. 087	3	309
4	4. 296	4	429	4	4. 116	4	411
5	5. 370	5	537	5	5. 145	5	514
6	6. 444	6	644	6	6. 174	6	617
7	7. 518	7	752	7	7. 203	7	720
8	8. 592	8	859	8	8. 232	8	823
9	9. 666	9	966	9	9. 261	9	926
10	10.740			10	10.290		
Glaſs 25 Seconds.				Glaſs 26 Seconds.			
1	0. 987	1	.98	1	0. 950	1	.95
2	1. 974	2	196	2	1. 900	2	190
3	2. 961	3	294	3	2. 850	3	285
4	3. 948	4	392	4	3. 800	4	380
5	4. 935	5	490	5	4. 750	5	475
6	5. 922	6	588	6	5. 700	6	570
7	6. 909	7	686	7	6. 650	7	665
8	7. 896	8	784	8	7. 600	8	760
9	8. 883	9	882	9	8. 550	9	855
10	9. 870			10	9. 500		

Glaſs

Glass 27 Seconds			
Knots	Miles & 1000 parts.	Fathoms	1000 parts of a mile
1	. 915	1	91
2	1. 830	2	183
3	2. 745	3	274
4	3. 660	4	366
5	4. 575	5	457
6	5. 490	6	549
7	6. 405	7	630
8	7. 320	8	732
9	8. 235	9	824
10	9. 150		

Glass 28 Seconds.			
Knots	Miles & 1000 parts.	Fathoms	1000 parts of 1 mile
1	0.882	1	88
2	1.764	2	176
3	2.646	3	264
4	3.528	4	353
5	4.410	5	441
6	5.292	6	529
7	6.174	7	617
8	7.056	8	705
9	7.938	9	794
10	8.820		

Glass 29 Seconds			
1	0. 852	1	85
2	1. 704	2	170
3	2. 556	3	255
4	3. 408	4	341
5	4. 260	5	426
6	5. 112	6	511
7	5. 964	7	596
8	6. 816	8	682
9	7. 668	9	767
10	8. 520		

Glass 30 Seconds.			
1	0. 823	1	82
2	1. 646	2	164
3	2. 469	3	247
4	3. 292	4	329
5	4. 115	5	411
6	4. 938	6	494
7	5. 751	7	576
8	6. 584	8	658
9	7. 407	9	741
10	8. 230		

The use of these Tables.

WHen the Glaſs is 23 Seconds, if the Ship runs out one knot in the time of one Glaſs, ſhe muſt run 1. 074 mile an hour, if two knots, ſhe runs 2 miles and $\frac{148}{1000}$ parts of a mile in one hour;

hour: and so for more knots, she must run more miles. and thousand parts of a mile *per* hour. The same you must understand of all the other Tables, according to the length of the responding Glasses.

But because the Ship doth not always run out even knots, but many times 1. 2. 3 knots and somewhat more, therefore that you may exactly know the Ship's motion, (when she runs more than an even knot) without guessing, I have thought of this following help, *viz.* take a Line equal in length to the distance between any two knots, divide this Line into 10 equal parts, and at each division make so many distinguishing marks, (by pieces of Leather, or several coloured cloth) as there are equal parts in the whole. This line so divided and marked, I call the Fathom-line.

The use of this Fathom-line is thus, when the Ship hath run out more than an even knot, apply this Fathom-line to the nearest knot in the Log-line, so shall this Fathom-line shew the number of Decimal parts of a knot which the Ship hath run more than an even knot. Then in each of the foregoing Log-Tables you have the Millesimal parts of a mile answering to the respective number of Fathoms: Thus, suppose a Ship (by a glass of 25 Seconds) runs out 4 knots and $\frac{8}{10}$, or 8 Fathoms in the space of 25 Seconds:

I demand how many miles and parts she runs in an hour?

In the Table of 25 Seconds, you find against 4 knots, stand 3. 948 miles, and against 8 Fathom in the same Table stand .784, which added

to

to 3.948 makes 4.732 miles, or 4 miles and $\frac{712}{1000}$ parts of a mile for the Ship's diſtance run that hour: and thus you muſt proceed with any other number of knots and Fathoms, which being very plain and eaſie, I need not ſpend more time in adding more Examples.

Thus I have demonſtrated that the Ship's motion at Sea depends upon the Glaſs: for when the Glaſs contains only 23, or 24 Seconds, the Ship then runs ſomewhat more than a Sexagenary mile every hour, and when the Glaſs contains 25, 26, 27, 28, 29, or 30 Seconds, then her motion is leſs than a mile each hour. Yet our Seamen commonly eſtimate the Ship runs ſo many miles every hour, as ſhe runs knots in the time of one Glaſs, let the Glaſs be any number of Seconds made at all adventure, and notwithſtanding this evident demonſtration; it is to be feared that Cuſtom and Prepoſſeſſion will not ſuffer them to embrace a Truth ſo practical, eaſie and uſeful.

CHAP. V.

To reduce Sexagenary Miles into English *Miles ; and the contrary.*

IN the third Chapter I gave you an account of ſome Experiments made for finding the quantity of a degree in a great Circle, upon the ſurface of the Earth or Sea, where it was demonſtrated that 69. $\frac{548}{1000}$ Engliſh miles anſwered to a degree. But at Sea we generally allow a degree to be divided into 60 equal parts, therefore 69. 548 divided by 60, the Quotient 1. 159 is the quantity of a Sexagenary mile : Hence it follows that to reduce Sexagenary into true Engliſh miles you muſt

Multiply 1. 159 by the number of Sexagenary miles, that product divided by 1000, the Quotient is the number of Engliſh miles required.

And on the contrary, to reduce Engliſh into Sexagenary miles, You muſt

Multiply the number of Engliſh miles by 1000, that Product divided by 1. 159 the Quotient gives the number of Sexagenary miles contained in all the given Engliſh miles.

Example

EXAMPLE.

In 234 Sexagenary miles, *I demand how many English miles.*

```
      1.159
        234
   ---------
       4636
      3477
     2318
  ------------
1)271 | 206 | 271 206/1000
      | 000 |
```

Thus it appears there are 271 $\frac{206}{1000}$ English miles in 234 Sexagenary miles.

But to reduce English into Sexagenary miles, as thus, let it be required to find how many Sexagenary miles there are in 234 English miles.

```
          234
          1000
       ---------
1.159) 234000 (201
         2241
          10
```

Answer there are 201 $\frac{1041}{1159}$ Sexagenary miles in the number of English miles given.

And thus it is evident, that all distances found by the Ship's motion at Sea, being computed according to the Sexagenary Division of a Degree, are lesser than they ought to be.

Divers other things might be drawn from the Principles in these two Chapters, which for brevity I omit to mention.

CHAP.

CHAP. VI.

The Doctrine of Plain Triangles.

THE whole Art of Navigation conſiſts in the application of Plain and Spherical Triangles. For all queſtions in Sailing upon the Plain and True Sea Chart, are reſolved by Plain Triangles: and all Geographical and Aſtronomical Problems are drawn from a Spherical Triangle.

DEFINITIONS. Fig. 10.

1. ACB, DCE, being two lines drawn through the Center C, are called Diameters.

2. A right line drawn from the Center C to the circumference of the Circle, is called the Semidiameter or Radius of the Circle; thus CA, CB, CD, CE, are called Semidiameters, or Radii.

3. An Arch is any part of the circumference of a Circle, thus FBI is called an Arch.

4. A Chord is a Right-line drawn from one end of an Arch to the other, thus FKI, is called the Chord of the Arch FBI, and alſo is the Chord of the Arch FAI, the Complement of the Arch FBI to a Circle.

5. The

5. The right Sine of an Arch, is a right line drawn perpendicularly from the term of that Arch upon the Diameter: or which is all one, the right Sine of an Arch is ½ the Chord of twice that Arch. Thus FB, BI are two equal Arches. FKI is the Chord of theſe two Arches, and FK ½ the Chord thereof is called the Sine of the Arch FB.

But the ſine of an Arch leſs than a Semicircle, is the ſine of the Complement of that Arch to a Semicircle, and thus FK is not only the ſine of the Arch FB, but alſo of its Complement to a Semicircle FDA.

6. If from C the Center of a Circle, through F the term or end of the Arch BF there be drawn an infinite right line, as CFG, and from B the end of the Diameter there be erected the perpendicular BG, and theſe two lines be continued till they meet at G, the Perpendicular line BG ſhall be the Tangent of the Arch BF, and the other line CG ſhall be the Secant of the ſame Arch.

By theſe Definitions it is evident that LF is the ſine of the Arch DF, and alſo the ſine of its Complement to a Semicircle, *viz.* of the Arch F BE. Alſo DH is the Tangent of the Arch DF, or the Tangent of the Complement of the Arch BF to a Quadrant. And CM is the Secant of the Arch DF or the Secant of the Complement of the Arch BF to a Quadrant.

The ſides of all Plain Triangles are meaſured by ſome line of equal parts, as of Leagues, Miles, Poles, yards, Feet, Inches, Barley-Corns, or any other leſs meaſure. Thus in Figure the 11. the

line AC is called the Hypothenusal, AB the Base, and BC the Perpendicular.

But AC in this Figure is made the Radius or Semidiameter of a Circle, and may be divided into 10, 100. 1000, 10000. or any other number of equal parts consisting of an Unite with Cyphers; then by definition the 5th BC will be the sine of the Arch CD, and AB will be the sine of the Arch AE, and these two sines will contain some certain number of equal parts, which must be measured by the same Scale wherewith AC was measured. Again, in Fig. 12. AB is made the Radius or Semidiameter of a Circle, and must be divided into some number of equal parts consisting of an Unite with Cyphers, then by definit. 6. BC is the targent of the Arch BD, and AC the Secant thereof, and these two, *viz.* BC, AC, must be measur'd by the same Scale wherewith AB the Radius was measured.

7. An Angle is the inclination of two lines the one to the other, as in Fig. 11. the lines CA, BA both meeting in one point A, make an Angle, and the point A where these two lines meet is called the angular point.

Sometimes there are many lines drawn from one angular point, as in Fig. 10. from the Center C, there are drawn the lines CA, CD, CF, CB, and the several Angles proceeding from this point C, are distinguished by three Letters, the middlemost whereof denotes the angular point. Thus the lines CA, CD make an Angle ACD, or DCA: the lines CD, CF make the Angle DCF, or FCD, and the lines CF, CB, make the Angle FCB, or BCF.

8. If

8. If any two lines making an angle, (or meeting one point) be perpendicular to each other, as are the two lines CA, CD, the angle ſo made is called a right angle, as ACD, which is always equal to the fourth part of a Circle or 90°. 00′.

9. An acute angle is always leſs than a right angle, as FCB, or BCF.

10. An obtuſe angle is always greater than a right angle as ACF, or FCA.

The angles of every Plain Triangle muſt be meaſured by a Circle deſcribed upon the angular point. Thus the Quadrant or right angle ACD contains 90°. 00′. and when it is known how many degrees are contained in the Arch BF, the meaſure of that angle is ſaid to be known.

From the foregoing definitions it is evident that any one of the three ſides of a right-angled plain Triangle may be made the Radius of a Circle, and then the other ſides will either be both Sines as in Fig. 11. or the one a Tangent, and the other a Secant, as in Figure 12, and theſe Sines, Tangents or Secants are called Natural: from which definitions, the Tables of Natural Sines, Tangents and Secants took their Original: by help whereof the Ancients did expedite the ſolution of all Plain Triangles. For when any one ſide of a right angled Plain Triangle is made the Radius of a Circle, and it be known how many parts of that Radius are contained in the other ſides, the ſolution of that Triangle is eaſily expedited from 4. 6. *Euclid.*

EXAMPLE.

In Figure 11. let the Radius AC contain 100000, and let the angle CAB (whoſe meaſure is the

Arch CD.) be 30°. then ſhall the angle ACB (whoſe meaſure is the Arch AE) contain 60°. 00′. but theſe two ſides AB, BC are Sines, by defin. 5. therefore in the Table of Natural Sines, find the Sine of 30°. which is 50000, and alſo the ſine of 60°. 00′. which is 86602, then it is evident that ſeeing CB is the Sine of the Arch CD, CB ſhall be 50000, and AB 86602, and thus the three ſides of this Triangle are known in parts of the Radius, then if the three ſides of this Triangle be meaſured by any other Scale (different from that whereof the Radius AC did contain 100000) the numbers or meaſures found by both theſe ſeveral Scales ſhall be proportional 4. 6. *Euclid.*

For let AC by any other Scale contain 246, then if you deſire to find the length of the other two ſides AB, BC, by the ſame Scale, Say

If AC 100000 require AC 246, what ſhall BC 50000 require. Anſwer 123, BC.

100000 — 246 — 50000
50000

123.00000

	AC	BC
Again, as AC 100000 —	246 —	86602
		246
		519612
		346408
		173204
		213.04092

Thus

Thus it is evident that if AC 100000 require AC 246, then BC 50000 will require BC 123, and by the fame proportion AB 86602, will require AB 213. The fame is to be underftood of Tangents and Secants.

And thus the bufinefs of Plain Triangles will appear plain and eafie:and the folution thereof by natural Arithmetick, is performed only by Multiplication and Divifion. And becaufe the practice of Multiplication and Divifion is very troublefome, and tedious, the renowned *Napier*, Baron of *Marcheſton*, has invented certain Logarithmical numbers, called Artificial Sines, Tangents, &c. which perform the bufinefs of Multiplication by Addition, and that of Subtraction, by Divifion.

Thus I have explained the nature of the Menfuration of Plain Triangles, I fhall now lay down fome other neceffary Precognita's, and then proceed.

THEOREM 1. Fig. 14.

If any two right lines crofs one the other, the oppofite angles fhall be equal.

Thus the two right lines AE, BD croffing each other in C, do make the angles ACD, BCE equal to each other.

Demonftr. from C as a Center, ftrike the Circle FGHI, then fhall IFG, GHI be two equal Semicircles,by 18 Def. 1. *Euclid.* alfo FGH,FIG fhall be two Semicircles; but all Semicircles having the fame Diameters, are equal to each other, and therefore thefe four are Semicircles mutually equal to each other.

Then if from the Semicircle IFG, you take away the Arch FG, there will remain the Arch IF: alſo if from the Semicircle FGH, you take away the Arch FG, there will remain the arch GH, therefore if from two equal Semicircles, IFG, FGH you take away the Arch FG, the two remaining arches IF, GH ſhall be equal to each other: but IF is the meaſure of the angle ACD, and GH is the meaſure of the angle BCE, therefore theſe two angles are equal. In like manner it may be demonſtrated that the angle ACB, is equal to the angle DCE.

THEOREM 2. Fig. 15.

If a right line fall upon two Parallels, it makes both the alternate Angles equal each to other.

Thus if the right line FH be drawn croſs the parallels AB, CD, the angles FEB, EGD ſhall be equal each to other.

Demonſtr. Seeing that by Hypotheſis the lines AB, CD are parallel to each other, and that FH is a right line croſſing AB in E, and CD in G, there can be no reaſon in Nature why it ſhould incline more to the one, than it doth to the other: and if it hath not a greater inclination to the one than it hath to the other, then muſt the alternate Angles FEB, EGD be equal.

THE-

THEOREM 3. Fig. 15, 16.

The three angles of any Plain Triangle, are equal to two Right Angles.

IN Fig. 15. from E let fall the Perpend EI, so shall GEI be a right angled Triangle: then by Def. 8. the angle EIG is a right angle, as also is the angle AEI, and this right angle AEI is by the line FH divided into two acute angles AEG, GEI, but by Theorem 1. the angle AEG is equal to the angle EGI, therefore the two acute angles EGI & GEI are equal to a right angle, and the angle EIG is right, therefore the three angles of a right angled Plain Triangle are equal to two right.

Hence it is evident, that if one acute angle in a right angled Triangle be given; if you subtract this acute angle from 90°. the remainer will be the other acute angle.

FIG. 16.

The three angles of an Oblique Plain Triangle are equal to two right.

The lines EG, HK are parallel to each other, therefore by Theor. 2. the angle EAB, is equal to the angle ABC: also the angle GAC is equal to the angle ACB, but the angle EAB is measured by the Arch DF, the angle GAC is measured by the arch IK, and the angle BAC is measured by the arch FK, and these three arches are equal to a Semicircle, therefore the three angles

of any oblique Triangle are equal to a Semicircle or two right angles.

Hence if in any oblique plain Triangle, there be any two of it's angles given, the ſum of theſe two given angles ſubtracted from a Semicircle or 180°. the remainer is the third angle.

AXIOM 1.

In all right-angled Plain Triangles, any of the three ſides may be made the Radius of a Circle, and the other ſides will be as Sines, Tangents or Secants. And what proportion the ſide put as Radius hath unto Radius; the ſame proportion hath the other ſides to the Sines, Tangents or Secants of the oppoſite angles by them repreſented.

IN Fig.11.the Hypothenuſal AC is made Radius, and therefore the Baſe AB ſhall be the Sine of the angle at C, and the perpendicular BC the ſine of the angle at A. Then let us ſuppoſe the length of the Hypothenuſal to be any number of Yards, Feet, Inches, &c. and the quantity of the angle at A to be known, and let it be required to find the length of the Perpend. BC in Yards, Feet or Inches, &c.

In the Solution of Triangles we muſt always have three parts given to find a fourth, and the parts given muſt either be two ſides and one angle; or the three angles and one ſide: or elſe the three ſides.

1. If we have given in a right angl'd Triangle the Hypothenuſal AC, and the Angle at A to find the Perpendicular BC, and that the Hypothenuſal

thenufal be made Radius : here before we can rightly underftand how to frame a Canon or proportion between thefe three given terms, and the fourth required, we muft confider the nature of thefe three given parts, as, whether they be angles or fides; but we find in this cafe, that the Hypothenufal is a double term, for it reprefents a fide; as being a line confifting of fome number of known parts, as Miles, Yards, Feet, Inches, *&c.* and it alfo reprefents an angle, as being the Radius of a Circle, and fubtending the right angle at B, and fo muft contain fome number of known parts, confifting of 1 and Cyphers, and the third term is an angle. Seeing then we have two terms of one kind, *viz.* both angular, we muft begin with that angular term which relates to the fide given, and then the Proportion will be as Radius AC is to the Hypothenufal AC. So is BC the fine of the angle at A, to the Perpendicular BC.

Again, fuppofe the fame parts to be given and required as afore, and that the Bafe AB in Fig. 12, be made the Radius of a Circle, then from Def. 1. it is evident that BC is the Tangent of the angle at A, and AC the Secant of the fame angle: therefore the angle at A is a double term, having relation both to the fide given AC, and to the fide required BC, and muft thus be ufed, *viz.* As Secant of the angle A, *viz.* AC, is to Hypothenufal AC, fo is Tangent of the angle A, *viz.* BC to the Perpendicular B C.

Laftly,

Laſtly, If the ſame parts be given and required, (only inſtead of the angle at A, you uſe its Complement to a Quadrant, *viz.* the angle C) then CA will be the Secant of the angle at C, and CB the Radius of a Circle, therefore the proportion will be, as CA the Secant of the angle at C, is in proportion to CA the Hypothenuſal, ſo is CB the Radius of the Circle to CB the Perpendicular required.

And by reducing your terms into this order, ſo that the firſt and third may be of one kind, you may eaſily diſcover the true Canon for reſolving any right-angled plain Triangle, as ſhall more largely appear in the following Caſes. And from this Ground may be drawn 24 ſeveral varieties or proportions, by making each ſide of the right-angled Triangle the Radius of a Circle.

ANNOTATION.

1. If the Perpendicular be made Radius, and there be given the Baſe and Hypothenuſal to find the angle at C, we have only two parts given, from whence no Canon can be drawn, becauſe, as I noted before, three parts muſt always be given.

2. The ſame thing will happen if the Perpend. and Hypothenuſal be given to find the angle at A, when the Baſe is made the Radius of a Circle.

3. The ſame is to be underſtood when we have the Baſe and Perpendicular given to find the angle at A or C, making the Hypothenuſal Radius.

All

All right-angled plain Triangles are uſually ranged under ſeven Caſes: whereof thoſe in which a ſide is required, *viz.* three, may be found by a Triple Proportion, according as each ſide is made the Radius of a Circle: and thoſe in which an angle is required, may be found by a Double Proportion.

AXIOM 2. Fig. 17.

In all Plain Triangles the ſides are proportional to the Sines of their oppoſite Angles.

Demonſt. About the Triangle ABC deſcribe a Circle, as BDAFCH from the Center O, then draw the prickt lines AO, BO, CO: it is evident from Def. 4. that the ſide AB is the Chord of the arch BDA: AC is the Chord of the arch AFC, and BC is the Chord of the arch CHB. From 20. 3. *Euc.* it is evident that the angle BOC is double to the angle BAC, then if you biſect the arch BHC, by the line OH, this line ſhall biſect BC in I, and the arch BH ſhall be equal to the angle BAC, but BI by Def. 5. is the Sine of the arch BH, and conſequently the Sine of the angle BAC, therefore the Sine of the angle at A, is equal to $\frac{1}{2}$ the ſubtending ſide BC.

In like manner it may be demonſtrated, that $\frac{1}{2}$ the ſide AB is equal to the Sine of the angle at C, and that $\frac{1}{2}$ the ſide AC is equal to the Sine of the angle at B: hence it follows, that what proportion the $\frac{1}{2}$ of any magnitude bears to that whole magnitude, the ſame proportion doth the $\frac{1}{2}$ of any

other magnitude bear to that whole magnitude. Therefore

As the ſine of the angle at A (which is ½ the ſide BC) is in proportion to the ſide BC:

So is the ſine of the angle at B (which is the ſide AC) to the ſubtending ſide AC.

AXIOM 3. Fig. 18.

In all plain Triangles, as the Sum of the two ſides containing the Angle given, is in proportion to their difference: So is the Tangent of the ½ Sum of the two unknown Angles, to the Tangent of ½ their difference.

Continue AB to D, and make BD equal to BC, and BF equal to AB, then draw BE, FG each parallel to AC, ſo ſhall the angle DBE be equal to the angle BAC, and the angle EBC ſhall be equal to the angle ACB, becauſe of the parallels BE, AC: and thus the angle DBC, is equal to the Sum of the two unknown angles ABC, ACB. But the Triangle DBC is Iſoſceles: if therefore from B you draw BI perpendicular to DC, it will biſect not only the angle DBC, but the ſide DC in I: therefore the angle DBI, or IBC ſhall be equal to half the Sum of the two unknown angles, *viz.* BAC, ACB, and becauſe EBC is equal to ACB, therefore the angle EBI ſhall be equal to half the difference of the two unknown angles: then becauſe the Triangles DAC, DFG are like by reaſon of the parallels AC, FG, therefore by 4. 6. *Euc.* their ſides ſhall be proportional. But AD is equal to the ſum of the two ſides

A B,

AB, and BC, and DF is the diff. of theſe two ſides, therefore, as the ſum of the two ſides DA. is to their difference DF.

So is the line DC, to the line DG, but if you make BI Radius, and IH equal to IE, then DC is the Tangent of the two unknown angles, and DG the Tangent of their difference equal to H E.

Again, if you draw FM parallel to IA, the Triangles DFM, DAI ſhall be like, and by 4. 6. *Euc.* their ſides ſhall be proportional. Then it is evident that DI (being $\frac{1}{2}$ of DC) is the Tangent of $\frac{1}{2}$ the Sum of the two unknown angles, and DM is equal to HI the Tangent of $\frac{1}{2}$ their difference, therefore, as DA is to DF, ſo is DI to DM, that is,

As the ſum of the two given ſides, *viz.* DA.

Is in proportion to their difference DF.

So is the Tangent of the $\frac{1}{2}$ Sum of the two unknown angles, *viz.* DI.

To the Tangent of half their difference DM, equal to HI, or IE. Then if you add the Tangent IE to the Tangent DI, it makes DE the Tangent of the angle DBE, equal to the angle BAC, and if you ſubtract the Tangent IE from the Tangent IC, it leaves EC the Tangent of the angle EBC, equal to the angle ACB.

AXIOM

AXIOM 4. Fig. 19.

In all Plain Triangles where there are given all the three Angles to find the three sides. As the true Base of the given Triangle is to the Sum of the other two sides. So is the difference of these two sides, to the alternate Base.

LET DBC be a Triangle given, whose three sides are supposed to be known, and let DB the shortest side be the Radius of a Circle, whose Circumference shall cut the line DC in F: continue the line CB to the circumference at A, and draw the lines AF and DH, and the perpend. BG, then shall AC be the Sum of the two sides BC, and BD, and CH shall be the difference of these two sides; Lastly, CF shall be the alternate Base. I say,

The Triangles CHD, CFA are equiangled, because of the angle C, which is common to both the Triangles; and therefore the sides of these two Triangles shall be proportional; therefore it follows, by Cor. 2, 36. 3. *Eucl.* that the Rectangle of CA, CH shall be equal to the Rectangle of CD, CF. But equal Rectangles have their sides proportional by 16. 6. Therefore as the true Base CD.

Is to CA the sum of the other two sides AB, BC. So is the difference of these two sides CH, to the alternate Base CF. Subtract CF from CD, the remainer is DF; from B let fall the Perpend. BG, which shall bisect DF in G, so have you

you refolved the oblique Triangle FCD into two right-angled Triangles BDG, BCG, in either of which we have the Hypothenufals and Bafes given to find the angles.

I might have demonftrated thefe Axioms according to the methods ufed by the late Reverend Dr. *Oughtred*, and Dr. *Ward*, the latter of which has comprized them in a very few words; but becaufe I have calculated this piece according to the Capacity of our ordinary Seamen, who are not generally qualifi'd to receive fpeculations fo nice, I chofe this prefent method of Expreffion to render the fundamentals of Trigonometry more perfpicuous and intelligible.

CASE 1 Fig. 20.

The bafe and angle at the bafe given to find the Perpendicular.

In the right-angled plain Triangle ABC, let the bafe AB be 94 parts, and the angle at A $38^{\circ}.\ 00'$ *I demand the Perpendicular BC.*

GEOMETRICALLY.

Draw the line AB, upon which fet the bafe 94 (taken from the line of equal parts) from A to B, and upon B erect the Perpend. BC.

From A with the Chord of $60^{\circ}.\ 00'$ ftrike the arch DE, and fet the angle given, *viz.* $38^{\circ}.\ 00'$ from D to E, draw the line AE, which continue to cut the Perpend. BC in C, fo fhall BC be the fide required, which meafured upon the fame line of equal parts, gives 74 parts

LOGA-

LOGARITMICALLY.

Making AC Radius, then by Axiom 1. ſay.
As ſine of the angle at C 52°. 00′. —— 989653
Is to the baſe AB 94 parts —— —— 197312
So is ſine of the angle at A 38°. 00′.—— 978934

1176246

To the ſide BC 74 parts —— —— 186593

Making AB Radius.

As the Radius ſine of 90°. 00′ —— —— 1000000
Is to the baſe AB 94 parts —— —— 197312
So is tangent of the angle A 38°. 00′— 989280

To the Perpendic. or ſide BC 74 —— —186593

Making BC Radius.

As the tangent of the angle C 52°. 00′—1010719
Is to the baſe AB 94 parts —— —— 197312
So is Radius ſine of 90°. 00′—— —— 1000000

To the Perpendic. BC 74 parts —— 186593

C A S E 2. Fig. 20.

The baſe and angles given to find the Hypothenuſal.

In

In the right-angled plain Triangles ABC, let the Base AB be 94 parts, and the angle at A 38° 00′. *I demand the Hypothenusal* AC.

The Geometrical Protraction of this Triangle is the same, as in Case 1.

LOGARITHMICALLY.

Making AC Radius.

As Sine of the angle C 52°. 00′. ———	989653
Is to the Base AB 94 parts — ———	197312
So is Radius Sine of 90°. 00′ ———	—1000000
To the Hypothenusal AC 119. 3 parts	207659

Making AB Radius.

As the Radius Sine of 90°: 00′. —	1000000
Is to the Base AB 94 parts——— ———	197312
So is the Secant of the angle A 38°. 00′.	1010346
To the Hypothenusal AC 119. 3 ———	207658

Making BC Radius.

As the Tangent of the angle C 52. 00.	1010719
Is to the Base AB 94 parts ———	197312
So is the Secant of the angle C 52. 00.- -	1021065
	1218377
To the Hypothenusal AC 119. 3 ———	207658

CASE 3. Fig. 20.

The angles and Hypothenuſal given to find the Baſe.

In the Triangle ABC let the angle at A be 38°. 00′ and the Hypothenuſal AC 119. 3 parts. *I demand the Baſe* AB.

GEOMETRICALLY.

Draw the line AB, and from A with the Chord of 60°. 00′. ſtrike the arch DE, from the ſame line of Chords, take the angle at A 38°. 00′. which ſet from D to E, and draw the AE at length: alſo from the line of equal parts take 119. 3 parts, which apply from A to C, biſect AC in F: from F with the diſtance FA croſs the infinite line AB in B. Laſtly draw BC, ſo ſhall AB be the Baſe required, which meaſured upon the ſame line of equal parts will be 94 for the length thereof required.

LOGARITHMICALLY.

Making AC Radius.

As the Radius AC, Sine 90°. 00′.——1000000
Is to the Hypothenuſal AC 119. 3—— 207658
So is the Sine of the angle C 52. 00.— 989653

To the Baſe AB 94 parts————197311

Mak-

Making AB Radius.

As Secant angle A 38°. 00′. —— —1010346
Is to the Hypothenufal AC 119. 3 parts 2:7658
So is Radius AB, Sine 90°. 00′. —— 1000000

To the Bafe AB 94 parts —— —— 197312

Making BC Radius.

As Secant of the angle C 52°. 00′ — 1021065
Is to the Hypothenufal AC 119. 3 parts 207658
So is the Tangent of the angle C 52°. 00′. 1010719

1218377

To the Bafe AB 94 parts.—— ——197312

CASE 4. Fig. 20

The Bafe and Perpendicular given to find an Angle,

In the Triangle ABC, let the Bafe AB be 94 parts, the Perpendicular BC 74 parts. *I demand the acute Angles* A and C.

GEOMETRICALLY.

Draw the line AB, and from the line of equal parts take 94, which fet from A to B: upon B erect the Perpendicular BC, and from the fame line take 74, which apply from B to C, draw

AC, and from A with the Chord of 60°. 00′ ſtrike the Arch DE, which being applyed to the ſame line of Chords, will give 38°. 00′. for the meaſure of the angle at A. Laſtly, from C with the Chord of 60°. ſtrike the Arch FG, which applied to the ſame line will give 52°. 00′. for the meaſure of the angle C.

In the 3 Annotation of Axiom 1. it is evident that the Hypothenuſal cannot be made Radius.

Making the Baſe Radius.

As the Baſe AB 94 parts ———	——197312
Is to Radius AB Sine of 90°. 00′ ——	1000000
So is the Perpendicular BC 74 parts ——	186593
To Tangent of the angle at A 38°. 00′	989281

Making the Perpendicular Radius.

As the Perpendicular BC 74 parts —	186593
Is to Radius BC Sine of 90°. 00′.———	1000000
So is the Baſe AB 94 parts ———	——197312
To Tangent of the angle at C 52°. 00′.—	1010719

CASE 5. Fig. 20.

The Baſe and Hypothenuſal given to find the Angles.

In the Triangle ABC, let the Baſe AB be 94 parts, the Hypothenuſal AC 119. $\frac{3}{10}$ parts. *demand the Angles* A and C.

GEOMETRICALLY.

Draw AB, and from the line of equal parts take 94, which ſet from A to B, upon B erect the Perpend. BC. and from the ſame equal parts take 119. 3. with which ſet one foot in A and with the other croſs the Perpendicular BC in C. Laſtly, draw the line AC, and from A and C deſcribe the Chord of 60°. 00′. which ſhall give the meaſure of the quantity of the angles A and C as in Caſe 4.

LOGARITHMICALLY.

Making A C Radius.

As the Hypothenuſal AC 119. 3 parts	207658
Is to Radius AC Sine of 90°. 00′.	1000000
So is the Baſe AB 94 parts	197312
To the Sine of the angle at C 52°. 00′.	989654

Making A B Radius.

As the Baſe AB 94 parts	197312
Is to Radius AB Sine of 90°. 00′.	1000000
So is the Hypothenuſal AC 119. 3	207658
To Secant of the angle at A 38°. 00′.	1010346

By Annotat. 1. Axiom. 1. the Perpendicular cannot be made Radius, if the angle at C be immediately required.

CASE 6. Fig. 20.

The Baſe and Perpendicular given to find the Hypothenuſal.

In the Triangle ABC, let the Baſe AB be 94, the Perpendicular AB 74. *I demand the Hypothenuſal* AC.

GEOMETRICALLY.

Draw AB and BC at right-angles to each other, and from the line of equal parts take the Baſe 94, which ſet from B to A, and the Perpendicular 74, from B to C, draw the line A C, which meaſured upon the ſame line of equal parts will give 119. 3 for the length of the Hypothenuſal required.

LOGARITHMICALLY.

By Caſe 4, find either of the acute angles, as the angle at A.

Making the baſe Radius.

As the baſe AB 94 parts ———	197312
Is to Radius AB Sine of 90°. 00′. ———	1000000
So is the Perpend. BC 74 parts ———	186593
To Tangent of the angle A 38°. 00′. ———	989281

Making

Making the Hypoth. Radius.

As Sine of the angle A 38°. 00′.	978934
Is to the Perpend. BC 74 parts	186593
So is Radius AC Sine 90°. 00′.	1000000
To the Hypothenusal AC 119. 3 parts	207659

CASE 7. Fig. 20.

The Base and Hypothenusal given to find the Perpendicular.

In the Right angled Plain Triangle ABC let the base AB be 94 parts, and the Hypothenusal AC 119. 3 parts. I demand the perpend. BC.

GEOMETRICALLY.

This Triangle is to be laid down or protracted as in Case 5.

LOGARITHMICALLY.

To resolve this Triangle by the Canon, there is required a double proportion, for first, by Case 5. you must find one of the acute angles, and then by Case 1*st*. the Perpendicular: but the same may more readily be thus effected.

Add the Base and Hypothenusal together, and find the Logarithme of their Sum; also Subtract the Base from the Hypothenusal, and find the Logarithm

garithm of their difference or remainer, add these two Logarithms together, ½ the Sum thereof shall be the Logarithm of the Perpendic.

AC 119. 3	Logarith. 213.3.	—	2328787
AB 94. 0	Logarith. 25.3.	—	1403121
Sum 213. 3	Sum of the Logarith.		3731908
Differ. 25. 3	½ Sum 74 Perp.—	—	1865954

Or in natural numbers by 47. 1. *Eucl.*

From the Square of the Hypoth. — 14232. 49.
Subtract the Square of the Base —— 8836.

Then out of the remainer. —— 5396. 49 extract the square root, which is 74 almost for the length of the Perpendicular.

If the Base and Perpendicular be given to find the Hypothenusal, then by 47. 1. To the square of the Base, add the square of the Perpendicular, and the square root of that Sum shall be the length of the Hypothenusal.

Oblique Triangles.

CASE 1*st*. Fig. 21.

Two Sides with an Angle opposite to one of them, to find the other Angles and the third Side.

In the Oblique-angled Plain Triangle ABC let the Angle at A be 34°. 00′, the Side AB 76. and the Side BC 89. I demand the angles at B and C. and the Side AC.

GEO-

GEOMETRICALLY.

Draw the line AC. from A with the Chord of 60°. 00. ſtrike the arch DE. and from the ſame Chords take the angle at A. which apply from D to E. draw the line AE. then from the Equal parts take 76 which apply from A to B. alſo from the ſame line take 89. with which diſtance ſet one foot in B. and croſs the line AC in C. laſtly draw the line BC. and upon the angular points B and C deſcribe two arches taking their Radii from the Chord of 60°. ſo ſhall FG 28°. 31′ be the meaſure of the angle C. and HI 117°. 29′ the meaſure of the angle B. and AC meaſured upon the line of Equal parts will be 141. for the length thereof.

LOGARITHMICALLY, by Axiom 2.

As the Side BC 89 parts——— ——— 194939
Is to the Sine of the angle A 34°. 00′—974750
So is the Side AB 76 parts——— ——— 188081

1162831

to the Sine of the angle at C 28°. 31′—967892

Then by Theor. 3. add the angles A and C together, their Sum will be 62°. 31′ which Sum ſubtracted from 180°. the remainer 117°: 29′ is the angle at B.

To

To find the Side AC.

As Sine of the angle at A 34°. 00′——974750
Is to the oppofite Side BC 89 parts——194939
So is Sine angle B 117°. 29′, or 62°. 31′ 994799

1189738

to the Side AC 141 parts —— ———214988

CASE 2. Fig. 22.

Two Sides with their contained Angle given to find the other Angles and third Side.

In the Oblique Triangle ABC let the Side AC be 141 parts, and the Angle A 34°. 00′. and the Side AB 76 parts. I demand the Angles B. C. and the Side BC.

GEOMETRICALLY.

Draw the line AC from A with the Chord of 60°. 00′ ftrike the Arch HI, upon which fet 34°. 00′ from H to I: draw the line AIB: and from the line of equal parts take 76 which fet from A to B and 141 of the fame, from A to C. then draw BC. and with the Chord of 60°. from B and C ftrike the Arches KL. MN. which being meafured upon the fame line of Chords will give the Quantity of the two required Angles. *viz.* C. 28°. 35′. and B 117°. 25′. alfo BC apply-ed

ed to the line of Equal parts will give 89 for the length thereof.

LOGARITHMICALLY by Axiom 3.

Add the two Sides AC 141. and AB 76 together, their Sum is 217: alſo ſubtract AB 76. from AC 141. the difference or remainder is 65. then Subtract the given Angle A 34°. from 180°. 00′ by Theor. 3. the remainder is 146°. 00′ which is called the Sum of the two unknown Angles: and 73°. 00′ is the ½ Sum thereof. Then ſay,

As the Sum of the two Sides AB.AC.217.233645
Is to their difference 65 — — — — — 181291
So is the tang.½ Sum of the unkno.ang. 73.1051466

1232757

to tang.½ the diff. of the unkno.Ang.44° 25′-999112

which ½ difference added to the ½ Sum of the two unknown Angles 73°. 00′. makes 117°. 25′ for the Angle at B.and Subtracted from this ½ Sum, the remainder is the leſſer Angle, or Angle at C. 28°. 35′. then to find the Side BC, ſay,

As the Sine of the Angle at C 28°. 35′ 967982
Is to the oppoſite Side AB 76 parts——188081
So is the Sine of the Angle at A 34.00—974750

1162831

to the Side oppoſite BC 89— parts — 194849

CASE

CASE 3. Fig. 22

The three Sides given to find the three Angles.

In the Oblique-angled Plain Triangle ABC, let the Baſe AC be 141. the Side AB 76. and the Side BC 89. I demand the angles A. B. C.

GEOMETRICALLY.

Draw the line AC. and from the line of equal parts take 141 which ſet from A to C: alſo from the ſame line take 76, with which ſetting one foot in A. ſtrike the arch B. and with 89 (taken from the ſame line of equal parts) ſet one foot in C, and croſs the arch B in B. then draw the lines AB. BC. and upon each angular point ſtrike the Arches HI. KL. MN. as in the Figure.

That done continue the Side BC to D. and from B. (with the diſtance BA) ſtrike the arch DAE, to cut AC in F. and DC in E: ſo ſhall CD be equal to the Sum of the two given Sides AB. BC. and CE ſhall be their difference; alſo CF ſhall be the Alternate Baſe: Laſtly from B let fall the Perpend. BG, which ſhall always fall in the middle of AF. then to find the alternate Baſe CF, ſay by Ax. 4.

As the true Baſe AC 141	214921
Is to Sum of the 2 ſides AB.BC.*viz.*.CD 165.	221748
So is the diff. of theſe two Sides CE 13	111394
	333142
to the alternate Baſe CF 15. 2	118221

Sub-

Subtract CF 15. 2 from AC 141. the remainer will be AF 125. 8. but AG is the half of AF or 62. 9. therefore if to GF (equal to AF) 62. 9, You add CF 15. 2. the Sum will be 78. 1 equal to GC. And thus the Oblique Triangle ABC is reduced into two right-angled Triangles, *viz.* AGB. CGB in either of which we have the Base and Hypothenusal given, to find the angles, which may be done by Case 5. making AC Radius

As the Hypoth. AB 76 —————— 188081
Is to Radius AB. Sine of 90 - 00 - —— 1000000
So is the Base AB 62-9 parts —— —— 179865

to Sine of the angle ABG 55°. 51'. —— 991784

which subtracted from 90°.00'. by Theor. 3. leaves 34°. 09' for the angle at A. Again

As the Hypothenusal CB 89 ——— 194849
Is to Radius Sine of 90°. 00' ——— 1000000
So is the Base CG 78. 1 —— ——— 189265

to Sine of the angle CBG 61°. 34' —— 994416

which subtracted from 90°. leaves the angle BCG 28°. 26'.

And for the clearer understanding of these several Proportions, grounded upon the preceding Axioms, I have here added a Synopsis of all the common Proportions both for right angled and oblique-angled Triangles.

Where note, that S. signifies Sine of any angle, t. the Tangent of any angle. Sec. the Secant of any angle. R. Radius.

: : propor-

: : proportional. + more, or to be added.
A. the angle A. — leſs, or to be ſubtracted.
B. the angle B.

A. C. the angles A and C. *&c.*

AB. AC. BC. or any two letters not having a point between them, ſignifies the Side AB. the Side A*&c.* Z the Sum, X the difference.

THE

The Proportions for all Right-angled Plain Triangles.

	Given	Requ.	Proportions. Fig. 23.
1	AC. R. AC. AB.	AC. BC.	S, C. A B :: R. A C. S, C. A B :: S. A. B C.
2	AB. R. A. AB.	AC. BC.	R. A B :: Sec. A. A C. R. A B .: t, A. B C.
3	BC. R. C. AB.	AC BC	t, C. A B :: Sec, C. A C. t, C. A B :: R. BC.
4	AC. R. A.C.AC.	AB CB	R. AC : : S, C. AB. R. AC : : S, A. BC.
5	AB. R. A. AC.	AB CB	Sec, A. A C : : R. A B. Sec, A. A C : : t, A. B C.
6	BC. R. C. CA.	AB CB	Sec, C. A C :: t, C. A B. Sec, C. A C :: R. B C.
7	AC. R. A.C. BC.	AC AB	S, A. B C :: R. A S, A. B C :: S, C. A B.
8	AB. R. A. BC.	AC AB	t, A. B C :: Sec. A. A C. t, A. B C :: R. A B.
9	BC. R. C. BC.	AC AB	R. B C :: Sec. C. A C. R. B C :: t, C. A B.
10	AC. R. AC. AB.	C	A C. R :: A B S, C
11	AB. R. AC. AB.	A	A B. R :: A C Sec. A.
12	AC. R. AC. BC.	A	A C. R :: BC S, A.
13	BC. R. AC BC.	C	B C. R :: A C. Sec, C.
14	AB. R. AB. BC.	A	A B. R :: B C. t, A.
15	BC. R. CB. BA.	C	C B. R :: A B. t, C.

THE

The Proportions for all oblique Plain Triangles, are these following. Fig. 23.

	Given	Requ.	Proportions. Axiom 2.
1	A B. A. B C.	B C. A C.	B C. S, A :: A B. S, C. the ∠, A. C. Subtracted from 180°. X is B. S, A. B C :: S, B. A C.
2	A B. C. B C.	A. B. A C.	A B. S, C :: B C. S, A. the ∠, A. C Subtracted from 180°. X is B. S. C. A B :: S. B. A C.
3	A C. B. B C.	A. C. A B.	A C. S, B :: B C. S, A. the ∠, B. A Subtracted from 180° X is C. S, B. A C :: S. C. A B.
4	A. B. C. A B.	B C. A C.	S, C. A B :: S, A. B C. S, C. A B :: S, B. A C.
5	A. B C. B C.	A B. A C.	S, A. B C :: S, C. A B. S, A. B C :: S. B. A C.
6	A. B. C. A C.	B C. A B.	S, B. A C :: S, A. B C. S, B. A C :: S, C. A B.
			Axiom 3. Fig. 23.
1	A B. A. A C.	C B. B C.	AB+A C. AC − AB :: t, B+C. t, B − C S, C. A B :: S, A. B C.
2	C B. C. C A.	A. B A B.	CA+CB. CA − CB :: t, B+A. t, B − A S. A. BC :: S. C. AB.
3	A B. A. B C.	A. C. A C.	BC+BA. BC − BA :: t, A+C. t, A − C S, A. B C :: S, B. A C.
			Axiom 4 Fig. 22.
	Preparation.		AC. BC+AB :: BC − AB. CG − GF that is AC.CD :: CE.CF. thus CF being found AC − FC = 2 AG. & AG + FC = CG
	AC. AB. BC.	A. B. C.	AB. R :: AG. S, ABG. Compt. BAG BC. R :: GC. S, CBG. Compt. BCG.

I have

I have now paſſed over the Geometrical and Logarithmical Solution of all Plain Triangles, in the ſeveral Caſes. I ſhall here give two or three Trigonometrical Problems, with application of ſome Caſes of Trigonometry to the buſineſs of Navigation

PROB. I. Fig. 24.

Having one Side of a right-angled Plain, Triangle, and the Sum of the other two ſides given, to find the angles and the other two ſides.

In the right-angled Plain Triangle ABC. let there be given AB 84 parts, and the ſum of AD. and BD 178 parts, I demand them ſeverally, and the angles at A and D.

GEOMETRICALLY.

Draw AB. ſet 84 equal parts from A to B. draw BC perpend. to AB. and ſet 178 equal parts from B to C. then draw AC. From A with any diſtance greater than $\frac{1}{2}$ AC. ſtrike the arch EF. and from C with the ſame extent croſs the arch EF. in E and F. then draw the line EF to cut BC in D. laſtly draw the line AD. ſo ſhall AD be equal to DC. and AD+BD ſhall be equal to BC.

LOGARITHMICALLY.

As AB — — — —	84. pts.	—192428
Is to Radius — —	90°. 00′ — —	1000000
So is BC— —	178 pts—	—225042

F to

to Tangent angle BAC 64. 44 — —— 1032614
which by Theorem 3. ſubtracted from 90°. 00′ the remainder will be BCA 25°. 16′. But in the Triangle AD.C, the Sides AD. DC are equal, therefore the angles DAC. DCA are equal. Subtract DAC from B AC ,the remainer will be BAD 29°. 28′. which ſubtracted from 90°. the remainer will be 50°. 32′ from the angle ADB.

As Sine of the angle ADB 50°. 32′—988761
Is to the Side AB 84 parts—— ———— 192428
So is the Radius——— 90°.00′——— 1000000

to the Side AD 108. 8 parts —— —— —-203667

which ſubtracted from 178 leaves 69. 2 parts for the Side BD required --

The application whereof may be this, ſuppoſe AB to being a broad Ditch,or River, 84 foot, and that BC being the height of a Tree ſtanding upon the Bank thereof be 178 foot. I demand where this Tree muſt be cut, ſo that the part cut off may reach from the top of the ſtanding part to the further ſide of the River? Anſwer it muſt be cut at D 69. $\frac{2}{10}$ foot from the Root.

P R O B. 2. Fig. 25.

One Side of an Oblique Triangle, the angle oppoſite to that Side, and the ſum of the other two Sides being given to find the two Sides ſeverally, and the angles oppoſite Angles to them.

LET the Side AB be 134 parts, and the angle at C 112°. and the ſum of the other two

two Sides, AC. ACB 156 parts, I demand them ſeverally, and the angles CAB, CBA.

Draw the line AD upon which ſet 156 equal parts from A to D: upon D make an angle equal to ½ the angle C *viz.* to 56°. 00′. and draw BD. then with 134 ſet one foot A, and with the other croſs DB in B. laſtly draw the angle CBD equal to the angle CDB. ſo ſhall AC be one of the Sides, and CB the other Side required.

LOGARITHMICALLY.

In the Triangle ADB, we have given AD 156. AB 134. and the angle ADB 56°. 00′. to find the angle ABD.

As the Side AB 134	212710
Is to Sine angle ADB 56 – 00	991857
So is the Side AD 156	219312
	1211169
To Sine angle ABD. 74°. 49′	998459

From which ſubtract the angle CBD 56. 00′ the remainer is 18°. 49 *viz.* the angle ABC.

As Sine angle ACB 112°.—00′	996716
Is to Side AB 134	212710
So is Sine angle ABC 18°. 49′	950858
	1163568
To the oppoſite Side AC. 46.6	166852

Which ſubtracted from AD. the remainer is CD 109. 4. equal to CB.

PROB. 3. Fig. 26.

To find the Diameter of the visible Horizon, that is, how far a man can see, by looking round about; either upon the Surface of the Earth or Sea.

FOR the Solution of this Prob. you must know that the Diameter of the Earth in English feet is 42078016, and consequently the Semidiameter thereof is 21039008 English feet: then let the Circle DBEF represent the ambit of the Terraqueous Globe, so shall BF be the Diameter, and BC or CD the Semidiameter thereof: then supposing the Eye of the Spectator, *viz.* A, be six foot above the Plain of the Horizon, so shall CA be 21039014 English feet: I say, if from A be drawn a line touching the Circumference of this Circle, as AD, it will limit the sight; for nothing can be seen from the point A below the point D. then draw CD. which by 18. 3. *Euclid*, will be perpendicular to AD, therefore the Triangle ADC is right-angled at D. But in this Triangle we have given CA the Hypothenusal, and CD the Base to find the Perpendicular DA, which by 47. 1. *Euclid* may be thus effected, *viz.*

From the Square of AC, subtract the Square of DC, the Square root extracted out of the remainer is the length of the Perpendicular. AD.

Thus AC 21039014, multiplyed by it self, produceth 442640110092196. and DC, 21039008. multiplyed by it self produceth 442639857624064. subtract the lesser of these two numbers from

he greater, the remainder will be 252468132; whose square root 15889 feet, is the length of the Perpendicular AD. and so many feet can the Eye see, when it is elevated 6 foot above the Plain of the Horizon, or convex Superficies of the Earth or Sea, and which reduced into miles, make 3 miles 49 feet.

Another Solution of this Prob. we may deduce from 36. 3 *Euclid*, for the Rectangle made of AF,and AB is equal to the Square of AD.

In Numbers thus, AF 42078022 multiplyed by AB 6 foot, produceth 252468132 Square feet, whose square root 15889 gives the number of feet in AD.

If it be objected that the visual Ray AD is greater than the arch DB, I answer, that seeing the Hypothenusal AC, and the Base CD of this Triangle differ but six foot, therefore the Perpendicular AD and the Arch BD cannot exceed each other six foot, which is but the 2648 part, and therefore inconsiderable.

PROB. 4. Fig. 27.

To find how far the Vertex of any Mountain, Steeple or Ship's Mast may be seen.

In the Solution of this Problem, we must have three things given, *viz.* the heighth of the Eye above the Horizon. AB which suppose to be 6 foot. Secondly the height of the Mountain, Steeple,or Ship's Mast,DE,which suppose to be 80 foot. Thirdly,The Semidiameter of the Earth GC, which, in the foregoing Problem, was 210390 8

Engliſh feet; then from the Figure it is evident that a Right line drawn from E to A muſt touch the Surface of the Earth or Sea in F. and if the Eye be placed at A. the point or object E being in a direct line with the tangent AF may be ſeen from A. then if to the point of Contact F be drawn the line CF it ſhall by 18. 3. *Euclid* be Perpendicular to AE; then by this Problem there is required the Quantity of the Arch BFD; which at two Operations may be thus found. To GD the Diameter of the Earth 42078016 add DE 80, the Sum is 42078096, which multiplyed by DE 80 produceth 3366247680; whoſe Square Root 58019 is the number of Engliſh feet equal to EF.

Again to BH=DG 42078016 add BA, 6 foot. the ſum is 42078022. this multiplyed by BA, 6 foot, produceth 252468132, whoſe ſquare Root 15889 gives the number of Feet in the line AF. But AF 15889, added to EF 58019 the Sum 73908 feet is the length of AE. this divided by 5280 the feet in an Engliſh mile gives 13.996 miles from the diſtance in which the Object DE may be ſeen.

And here alſo the difference between the Right line AE and the Arch BFD is inconſiderable.

COROLLARY 1.

Hence it is evident that if the heighth of a Ship's Deck from the Surface of the Water, and the heighth of a Man's Eye from the Deck be given, the diſtance of any other Ship at Sea, juſt beginning to appear, may be found

CO-

COROLLARY 2.

Alſo if the diſtance of the top of any Mountain and the point of Contact be given, the height of that Mountain may be found by 47. 1. *Euclid.*

Divers other Concluſions of this nature fall under this head which I muſt omit at this time, leſt what I deſign for a Manual, inſenſibly grow greater than I intended.

The explication of the Table of Proportions for Plain Triangles. In number 1. Axiom 1. AC. R. ſignifies the Side AC is the Radius of the Circle. AC. AB ſignifies the angle at A. angle C. and Side AB are given.

S, C. AB : : R. AC is thus to be read. As Sine of the angle C is in proportion to the Side AB. So is the Radius AC to the Hypothenuſal AC. And thus you may underſtand how to read all the Proportions in the 1*ſt*. and 2*d*. Axioms.

In AXIOM 3.

In number 1. we have given the ſide AB. the ſide AC. and the angle A to find the angle C and B. and the ſide BC. the Proportion is thus expreſt. As AB+AC. AC+AB : : tB+C. t. B—C. that is as AC added to AB. is to AB ſubtracted from AC. (that is the difference between AB. and AC.) ſo is the ſum of the angles B and C. to the difference of the angles B and C. the reſt need no explaining.

The Art of Navigation, DEMONSTRATED FROM THE PRINCIPLES OF GEOGRAPHY.

CHAP. 7.

Of the Position of Places.

GEography is a mixt Mathematical Science teaching us the true Notion of the Earth in relation to its Figure, Place, Magnitude, and other Properties.

It is divided into two Parts, *viz.* universal and particular. The Universal, teacheth us to consider

confider the Earth in general, and to explain all the affections and proprieties thereof, without taking notice of particular Countries. The particular confidereth the conftitution of all the feveral Countaies of the Earth.

This Art or Science of Geography is no new thing, nor was it (as *Lucius* fays of the Roman People,) *unius ætatis*, the Production of one age, but of many; For the antient Geographers were continually at work upon the Chorography of Kingdoms or Countries, and the Topography of particular places. Thus we find the Conquering Romans, who when they had fubdued any Province, commanded the Survey thereof to be taken, and upon their Triumphs to be expofed to the Eyes of the Spectators. And we fee, that War which is commonly the ruine of moft other Arts and Sciences, has alwayes continued a Friend to Geography; witnefs *Alexander*'s *Afiatick* Expedition, as *Pliny* tells us, at which time he took along with him two Surveyers, or Meafurers, *Diogetus* and *Beto*, to whofe performances the Geographers in fucceeding Ages, were much indebted. Yet notwithftanding all this diligence ufed by the Antients, the Maps which they produced and left to pofterity were very imperfect and falfe; becaufe they were altogether ignorant of feveral Parts of the Earth, which in after times (upon the difcovery of the Magnet) were found out: for it was impoffible till that happy difcovery was made) to Sail round the Globe. I mean not that they were ignorant of the fecret property of the Magnets attracting of Iron, for this they underftood; but that it was capable of a

peculiar

peculiar directions to a Meridional Position, was a secret they never imagined: And even this useful Arcanum had remained perhaps for ever undiscovered, if (like the invention of Gun-powder) some particular accident had not lead us to the Consideration of it; as you may see more at large in *Kercher de Magnete.*

Nor would this secret Property of the Stone have been of use further than in private Speculations, if Navigation had been unknown.

For by this Art, Geography has attained its present improvement; and it is not to be doubted but that by the help of Navigation it will in succeeding Generations be brought to perfection.

In what Age of the World, Men first began to think of Travelling by Sea, is somewhat difficult to determine. We are certain that *Europe* was at first peopled upon all the Sea Coasts from the East, and therefore Navigation was very Ancient. Accordingly *Moses* in describing the first Peopling of the World, calls *Euorpe* by the name of Isles of the *Gentiles*, implying that the *Jews* accounted it's several Regions accessible to them only by Water, after the manner of Islands. The several Colonies sent in the first Ages by the *Egyptians Phænicians* and *Greeks* through the *Mediterranean* are further Testimonies of this thing. *Jacob* in his blessing of *Zebulon*, mentions Ships upon the *Mediterranean*, as a thing well known in his dayes. The Antient *Phœnicias* Traded as Merchants, and are celebrated in Scripturf for it. *Ezek.* 27. and when *Solomon* built a Navy upon the Read Sea, he used *Phœnician* Pilots.

The Ship *Argos* built only to Sayl throug the *Euxim* Sea to *Colchos* was the first of Note among the *Greeks*, and therefore was by the *Antients* placed in Heaven among the Constellations in Memory thereof. *Minos* King of *Crete* is reputed the first who built a Navy of Ships for War, and Ruled over the Seas. And in his dayes *Dedalus* with his Son *Icarus* were the first who applied Masts and Sayls to Ships. For till then they Sayled only by Oars. Others invented Rudders, Anchors, the Compass and other things, by which Shipping has been gradually brought to the perfection in which we find it at present.

As the Science of Geometry was occaſionally diſcovered by the frequent Inundations of the River *Nilus*: and that of Aſtronomy by the *Chaldean Shepherds*; and as theſe two admired Arts in their firſt appearance to Man were rude and impoliſhed. For Geometry was only imployed in finding out each man's *Quantum* of Ground, when the overflowings of *Nile* had defaced the ſtated Land-marks. And Aſtronomy was no further regarded than in noting the ſeveral magnitudes of the Stars, and reducing ſome few of them into Conſtellations. So this Art of Sailing (when firſt it was thought on) was as imperfect as either of the other. The firſt Veſſels being not much unlike thoſe Canoes we find ſtill uſed by the Indians. But theſe poor open Veſſels were afterwards improved, and in a long tract of time attained to the perfection which we ſee at preſent.

Navigation (upon which the perfection of Geography does depend) is an Art or Science which teacheth us how to direct a Ship through the untract Ocean, from any one place to any other aſſigned.

Without the knowledge of the Poſition of Places, it is altogether impoſſible to underſtand this Art of Direction. And the Poſition of Places cannot be underſtood, till it be known what Latitude and Longitude thoſe places lie in.

In the firſt Chapter I gave you ſome general Definitions of thoſe two Terms, and here I ſhall further explain them.

1. The

1. The Circle of Longitude of any Place upon the Surface of the Terraqueous Globe, is that Circle which paſſeth through that Place, and alſo through both the Poles of the Earth. This Circle of Longitude is alſo called the Meridian; for the Meridian of any Place and the Circle of Longitude of the Place are one and the ſame Circle, diſtinguiſhed only by their uſe. For the Meridian reſpects the motion of the Stars: and the Circle of Longitude reſpects the Extenſion of the Earth without any regard to the Celeſtial Motions. Theſe Meridians, or Circles of Longitude, upon all Globes are uſually drawn through every 10*th*, or 15*th* degree of the Equator, and upon Maps, they uſually paſs through every Degree of the ſame.

2. The Longitude of any Place is the diſtance of the Meridian of that Place from ſome other particular Meridian. It is alſo ſometimes called an arch of the Equator or Parallel intercepted between the Meridian of any one Place, and any other certain Meridian. And this Meridian from which the Meridians of all other Places are numbered, *viz.* from Weſt to Eaſt is called the firſt Meridian, and the Longitude of the whole Earth is called its extenſion from Weſt to Eaſt, meaſured in the Equator. Thus then, the firſt Meridian (being the *Terminus à quo*, or beginning of Longitude) is ſaid to lye in no Longitude; if any place therefore lye 1, 2, 3, or 50, 70, 140, 320. *&c.* degrees diſtant from the firſt Meridian, *viz.* counting from Weſt to Eaſt in the Equator, the number of degrees in which this

this ſecond place lyeth, is called the Longitude thereof.

3. The diſtance of any one place from another is the ſhorteſt line intercepted between theſe two places, upon the ſurface of the Earth. Hence then as the Terraqueous Globe is Spherical, all lines drawn upon the Surface thereof muſt be Spherical, and therefore the diſtance between any two places muſt always be an arch of a Circle.

That the true Idea or Notion of Longitude may be more exactly apprehended by one ordinary Seaman, (for whoſe uſe alone I undertook the Compoſure of this piece) I ſhall caſt my thoughts into theſe following Propoſitions.

PROP. 1.

Nature her ſelf has placed no particular beginning or term of the Earth's extenſion from Weſt to Eaſt, (or according to the Equator,) hence any of the Meridians may be taken for the firſt Meridian, or beginning of Longitude.

Every Superficies whether Plain or Curved, is determined and meaſured by two diviſions, or extenſions; of which extenſions, the one is called the length or Longitude of that Figure or Superficies, and the other the breadth or Latitude thereof, and the length and breadth of any Superficies is always conceived to be perpendicular to each other: Nor do theſe two extenſions differ from each other in nature, for that which we aſſume for the Longitude, may likewiſe be aſſumed for the Latitude, and the contrary: but

uſually

uſually when theſe two extenſions are unequal, we aſſume the longeſt for the Longitude, and the ſhorteſt for the Latitude.

Thus in ordinate Figures, as in the equilateral Triangle, the Square, *&c.* theſe two extenſions being equal, there is no difference between the Longitude and Latitude of them. In like manner the Figure of the Earth being Spherical, the Dimenſions thereof are equal, and ſo the length and breadth, or Latitude and Longitude thereof muſt not differ, but onely according to our Conceptions, that theſe two terms may be more obvious to us. But why the one ſhould be called Longitude rather than the other, we will here enquire.

Seeing that the *Meridians* do all meet in the Poles of the Earth, which are alwayes a Semicircle aſunder from each other. This Semicircle we will take for one of the Earth's Dimenſions; and ſeeing the Equator equidiſtant every where from thoſe two Poles, is continued without interruption, to a whole Circle, we will take this for the other Dimenſion of this Spherical Surface; but this being a whole Circle is longer than the other being onely a Semicircle, therefore the Equator muſt be the Meaſure of the Earth's length or Longitude, and the Meridian, the Meaſure of its breadth or Latitude. In the Second Chap. I ſhewed you how to find the Latitude of any Place by an obſervation of the Sun's or any Star's Meridian Altitude; I will here ſubjoyn ſome particular Methods for finding the Longitude of any Place by obſervation.

PROP.

PROP. 2.

To find the Longitude of any Place by obſervation.

The Method for finding the Latitude of any Place depends upon the immobility of the Poles of the World, and the proceſs for finding the Longitude of any Place depends upon the inequality of the motion of Celeſtial Bodies: for if both the Fixed Stars and the Planets be moved with an equal degree of Velocity from Eaſt to Weſt, every of theſe in the ſame number of Hours ſhall paſs through all the Meridians of the whole Earth. But according to the truth of the matter (by reaſon of the inequality of the motion of the Celeſtial Bodies) if any fixed Star comes to any Meridian at 12 H afternoon, it ſhall come to that Meridian which is 90°. diſtant to the Weſtward at 11. H. 59 M. and conſequently the Errour of one Minute of time, in the Sun's Motion, produceth an Errour in Longitude of about 90 D.

Alſo if the Moon (whoſe motion is the ſwifteſt of all) comes to any Meridian at 12 a Clock, we ſhall come to a Meridian which lyes 7D. 12′ Weſtward, about 12 H. 1 M. and therefore from the Errour of one Minute of an hour in the Moon's motion from the Sun, ariſeth an Errour of 7°. 12′ in the Longitude of the Place propounded, and in the motion of the ſame Moon from any one fixed Star riſeth an Errour of 6°. 48′. and in the ſame manner the Errour increaſeth in the reſt of the Planets, both from the Planets

Place

Place taken by obſervation, and from the Tables calculated according to the proportion between the motion of the Planet obſerved, and the motion of the *Primum Mobile*.

Then ſeeing the difference of Longitudes cannot be obtained by help of Celeſtial obſervations, unleſs the Hours of both Places be firſt known whoſe difference of Longitude, is ſought, it is evident that if the Errours at both Places be not of the ſame denomination, and leſſer than one minute of time, the Errour of Longitude cannot be leſs than 13°.

Hence it is manifeſt how difficult (if not impoſſible) it is to find the Ship's Longitude at Sea by obſervation of the Celeſtial Bodies, and that the whole uſe of ſuch Obſervations is to be referred to Geography and Aſtronomy. However ſeeing it may be of uſe for our Seamen to know theſe various Methods, I ſhall here inſert them.

METHOD 1.

To find the Longitude of any Place by an Eclipſe of the Moon.

This way would be of very great uſe if we could ſee an Eclipſe every night: and may thus be effected. At that moment of time when through a Teleſcope you obſerve the beginning or middle of an Eclipſe, You muſt take the Altitude of a fixed Star, whether it be upon the Meridian or in any Azimuth, it matters not; but if the Star be in the Meridian, You may (if You knew it not before) find the Latitude of the Place;

Place; which Aſtral Altitude (being taken) find the hour of the Night with all poſſible exactneſs; which is moſt eaſily done by this following Rule, if the Star be upon the Meridian, *viz.* To the Complement of the Sun's Right Aſcen. in H. M. add the Star's Right Aſc. in H. M. the ſum is the time required. Compare this time of the Night thus found, with the time of the beginning or Middle of the Eclipſe, found by the Almanack or Ephemeris calculated for that Eclipſe, and the difference between thoſe two, is the difference in time between the Place for whoſe Meridian the Ephemeris was calculated, and the Place where this obſervation was made. And the Longitude of the Place where this obſervation was made, may be found by converting the Hours and Minutes in the difference in time between the two Places, into Degrees and Minutes of the Equator.

METHOD 2.

To find the Longitude of any Place, having the Moon's Place in the Zodiac given.

Altho' the preceding Method by an Eclipſe of the Moon be the moſt accurate, yet becauſe Eclipſes ſeldome happen, and when they do, are not viſible in all Places, therefore the precepts there delivered are not ſo uſeful to Seamen at Sea; being rather accommodated to the Shore; and thereby the Longitudes of moſt Places were diſcovered; but to our preſent purpoſe.

Find the true moment of time in which the Moon comes to the Meridian, and thereby the Longitude of any Place required may be found after this manner.

In the Place of Obſervation, (the Latitude being known) find the Altitude of any known Star, and thereby the hour of the Night with all imaginable accuracy: but note that the Altitude of the Star muſt be taken preciſely when the Moon is upon the Meridian. Next, find what degree of the Zodiac or Ecliptic is in the *Medium Cœli* at that ſame inſtant of time and thus for the time found we have the Moon's true Place in the Zodiac. Then from the Tables calculated for the Meridian of that Ephemeris find the hour in which the Moon ſhall be in that point of the Zodiac: and we ſhall have the horary difference in time between the two Places, *viz.* of the Place where the Obſervation was made whoſe Longitude is unknown, and alſo of the Place to whoſe Meridian the Ephemeris was calculated: and then proceed as in the former Method.

METHOD 3.

To find the Longitude of any Place by the Satellites of Jupiter.

Many there are who prefer this Phænomenon before others, becauſe the Satellites of *Jupiter* have no ſenſible Parallax, and in every Poſition of *Jupiter* above the Horizon, are conveniently to be obſerved. About this Glorious Planet *Jupiter* the

are four Satellites (invisible to most naked Eyes, tho' very easily perceived through a Telescope) which continually move round about *Jupiter*, respecting him as their Common Center. Their proper motion by which they are carried about *Jupiter* (for their diurnal motion, and their motion in the Ecliptic is common to all the fixed Stars, to *Jupiter* and the rest of the Planets) is swift: That which is nearest to *Jupiter* . finisheth his circuit in one day, 18 Hours. The Second in 3 Dayes 13 Hours, the Third in 7 Dayes two Hours, and the Fourth in 16 Dayes 18 Hours. If then you would find the Longitude of any Place by the Stated Motions of the Satellites, You must (by a most exact Telescope) observe the conjunction of any two of these Satellites with *Jupiter*, and to that moment of time in which you make this Observation find the true time either by the Meridian Altitude or other Azimuthal Altitude of any known Star : then in Your Tables of the Motions of these Satellites, find the true time, in which the Conjunction (You observe) shall happen ; *viz.* at the Meridian of the Place by which the Tables were calculated : and thus You have as afore the difference in Time between the Meridian of the Tables, and the Meridian of the Place of Observation, which being reduced into Equatorial Degrees, gives the difference of Longitude between these two Meridians.

But seeing that these Tables (for want of a sufficient number of Observations) are not arrived to their desired perfection, I shall only give you this following : but dare not recommend it to Your Use for finding the Ship's Longitude at Sea.

A Table of the Eclipses of Jupiter's Satellites, *visible under the Meridian of the Observatory, or near it,* Anno 1693.

January

D.	H.	M.	Satel.	
2	8.	27	4	I
2	10.	51	4	E
3	11.	23	2	E
4	9.	40	3	I
4	12.	49	3	E
5	14.	02	1	E
7	8.	32	1	E
10	13.	58	2	E
11	13.	39	3	I
14	10.	24	1	E
16	4.	53	1	E
19	5.	02	4	E
21	5.	21	2	E
21	12.	18	1	E
23	6.	47	1	E
28	8.	28	2	E
23	14.	14	1	E
30	8.	42	1	E

February

D.	H.	M.	Satel.	
2	3.	50	3	I
4	11.	5	2	E
6	10.	38	1	E
8	5	7	1	E
9	5.	48	3	I
9	8.	53	3	E
11	13.	33	2	E
13	12.	30	1	I
15	7.	04	1	E
16	9.	42	3	I
16	12.	55	3	E
22	5.	41	2	E
22	9.	01	1	E

March

D.	H.	M.	Satel.	
1	8.	21	2	I
1	10.	50	1	E
[illegible]	11.	0	2	E
10	7.	36	1	E
10	8.	53	4	E
10	11.	54	4	E
17	9.	24	1	E
24	9.	13	3	E
24	12.	22	1	E
31	10.	00	3	I

April

D.	H.	M.	Satel.	
2	7.	48	1	E
2	8.	17	2	E
9	9.	45	1	E
9	10.	56	2	E
25	8.	8	1	E

May

D.	H.	M.	Satel.	
2	10.	3	1	E
4	8.	8	2	E
6	9.	27	3	E
[illegible]	9.	24	4	I

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July

D.	H.	M.	Satel.	
3	15.	15	2	I
5	15.	25	4	I
15	15.	38	1	I
21	12.	57	1	I

August

D.	H.	M.	Satel.	
4	14.	55	2	I
7	15.	51	1	I
14	12.	53	3	I
14	17.	7	1	I
22	14.	11	1	I
30	16.	7	1	I

September

D.	H.	M.	Satel.	
5	14.	41	2	
8	12.	32	1	I
10	15.	41	4	I
15	14.	27	1	I
19	13.	26	3	E
2	16.	22	1	I
26	13.	57	4	I
26	17.	27	4	I
27	14.	3	4	E
29	18.	18	1	E
30	11.	50	2	E

October.

D.	H.	M.	Satel.	
1	12.	47	1	I
3	17.	57	3	I
7	14.	26	2	I
8	14.	41	1	I
14	16.	2	2	I
15	16.	35	1	I
22	18.	29	1	I
24	12.	58	1	I
25	9.	24	3	E
31	11.	50	1	I

November

D.	H.	M.	Satel.	
1	9.	52	3	I
1	11.	28	2	I
1	13.	24	3	E
2	9.	19	1	E
7	16.	42	1	I
8	13.	49	3	I
8	4.	1	2	I
8	17.	20	1	E
9	11.	10	1	I
14	18.	34	1	I
15	16.	34	2	I
15	17.	45	3	I
16	13.	3	1	I
16	15.	46	4	I
16	20.	15	4	E
18	7.	30	3	I
22	19.	6	2	I
23	14.	53	1	I
25	9.	20	1	I
26	8.	22	2	I
[illegible]	16.	41	1	I

December

D.	H.	M.	Satel.	
2	11.	10	1	I
3	9.	39	4	I
3	11.	2	2	I
3	14.	12	4	E
7	18.	33	1	I
9	13.	01	1	I
9	13.	26	2	I
11	7.	28	1	I
14	9.	26	3	I
16	14.	50	1	
17	15.	57	2	
18	9.	18	1	
20	8.	8	4	I
21	5.	13	2	
21	13.	22	3	
23	16.	42	1	
24	18	29	2	
25	11.	10	1	
27	5.	39	1	
28	17.	18	3	
30	18.	33	1	

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The explication and use of the foregoing Table.

First, you muſt have in readineſs a Tube or Teleſcope 12 or 14 foot long, which directed to *Jupiter* will ſhew his Satellites; which, otherwiſe, are inconſpicuous to moſt Men.

Secondly, at the time of obſervation (which muſt alwayes be when ſome or other of theſe are in Eclipſe,) You muſt find the true time of the Night, either by the Altitude of a Star in any Azimuth; or by any Stars coming upon the Meridian at that time.

Then by comparing the Time between the Meridian for which the foregoing Table was Calculated, and that which You find either by the Culmination of any Star, or it's Altitude upon any other Azimuth, You may attain the difference in time between theſe two Meridians: which difference reduced into Degrees and Minutes ſhews the Longitude of the Place required, or the diſtance of thoſe two Meridians at the Equator.

The Table it ſelf ſhews You all the Eclipſes of the four Satellites for every Month of the Year, and upon what day of the Month, and hour and Minute of the Day each Eclipſe happens. The Letter E ſignifies the Emerſion or end of the Eclipſe, and I the Immerſion or beginning thereof. Thus againſt *September* 26 You find 13 H. 57 Minutes, and in the reſponding Satellite

Column You find 4 $\left\{ \begin{array}{l} \text{I.} \\ \text{E.} \end{array} \right.$

the meaning whereof is that upon *September* 26*th*. at 13 H. 27 M afternoon, the 4*th*. Satellite immergeth, or entereth the Shadow of *Jupiter*, and at 17 H. 27 M. the ſame Satellite emergeth again from the Shadow of *Jupiter*, and conſequently the Eclipſe then endeth.

Alſo againſt *December* 2. ſtands 11 H. 10 M. againſt which ſtands 1 I. which ſhews that the firſt Satellite immergeth or beginneth to be Eclipſed that day at 11 H. 10 M afternoon. And upon *December* 30. the Table ſhews You that the ſame 1 Satellite emergeth or ceaſeth to be Eclipſed at 18 H. 33 M afternoon.

The uſe of all which is this.

Admit I be at Sea *October* the 8*th*. 1693. and by my Teleſcope I find the Immerſion of the firſt Satellite at 3 a Clock 48 M. paſt, in the Morning, *viz*. by an obſervation taken of ſome Stars Altitude, but by the Table I find the Immerſion to be 14 H. 41 M. therefore

	H M	H M
From the obſerved time	3. 48, adding 12 H	15 48
Subtract the Tabular time		14. 41
the remainer is		1. 07

which may thus be reduced into Degrees and Minutes. You muſt know that for every Hour in time, 15°. 00′ of the Equator muſt paſs the Meridian; therefore find the Minutes in the diffe-

rence

rence in time, which in this Example is 1 H. 07 M. *viz.* 67 minutes. Alſo find the Equatorial minutes in 15°. 00′. by multiplying 15° by 60, the Product 900, gives the Equatorial minutes required, then ſay

If 60. 900 :: 67
900

6 | 6030 | 0 | 1005 Minutes.
| 0 |

divide 1005 by 60 (the minutes in a Degree, and the Quotient is 16°. 45′. for the diff. in Longitude between the Meridian of the Ship, and that of the place for whoſe Meridian the Table was calculated.

But this way, which really is very exact, labours under two inconveniencies ſcarce to be remedied, *viz.* the almoſt impoſſibility of finding true time at Sea, and of managing a Teleſcope 10 or 12 foot long on board of a Ship.

A Catalogue of the Eclipses of Jupiter's *Satellites visible under the Meridian of the Observatory, or near it,* Anno 1694.

January

D	H. M.	Satel.	
1	15. 20	1	E
3	9. 48	1	F
4	13. 03	2	E
5	4. 16	1	E
8	17. 12	1	E
10	11. 40	1	E
11	15. 51	2	E
12	6. 08	1	E
15	5. 04	2	E
17	13. 33	1	E
18	18. 21	2	E
19	8. 02	1	E
19	8. 44	3	E
22	15. 18	4	I
22	17. 39	2	E
24	15. 07	1	E
25	8. 56	1	E
26	12. 43	3	E
28	4. 2[illegible]	1	E
29	10. 15	2	E
31	17. 2[illegible]	1	E

February

D	H. M.	Satel.	
2	11. [illegible]	1	F
4	6 19	1	F
6	12. 5[illegible]	2	F
8	9. 25	4	I
8	14. 05	4	I
9	13. 46	1	E
9	17. 08	3	I
11	8. 1[illegible]	1	F
12	15. 28	2	E
16	14. 42	1	E
18	10. 12	1	F
19	18. 06	2	F
2[illegible]	7. 2[illegible]	2	E
24	4. 48	3	E
25	8. 21	4	F
25	12. 09	1	I
27	6. 37	1	E

March

D	H. M.	Satel.	
2	10. 14	2	E
3	8. [illegible]0	3	E
4	14. 06	1	E
6	8. 35	1	E
9	12. 42	2	E
10	9. 1[illegible]	3	I
10	12. 5[illegible]	3	E
11	16. 03	1	E
13	10. 32	1	E
17	13. 18	3	I
17	16. 55	3	E
20	12. 3	1	E
22	7. 00	1	E
2[illegible]	7. 20	2	E
2[illegible]	8. 57	1	E
[illegible]	[illegible]5. 58	4	I

April

D	H. M.	Satel.	
3	9. 5[illegible]	2	E
[illegible]	10. 5[illegible]	1	E
1[illegible]	12. 27	2	E
12	12. 52	1	F
14	7. 21	1	E
1[illegible]	9. [illegible]	3	E
16	10. [illegible]	4	I
21	9. 17	1	E
22	9. 28	3	I
22	13. 05	3	F
28	11. 13	1	E
29	13. 2[illegible]	2	I

May

D.	H. M	Satel.	
5	9. 47	2	E
14	9. 31	1	F
28	9. 4	3	E

June

D.	H. M	Satel.	
3	9. 3	4	E
6	9. 41	1	E

July

Conjunction of Sun and Jupiter

August

D.	H. M	Satel.	
3	17. 3	1	I
5	16. 32	2	I
19	15. 23	1	I
28	15. 16	4	E

September

D.	H. M	Satel.	
11	15. 39	1	I
12	17. 19	3	I
18	17. 35	1	I
23	13. 59	1	I

October

D.	H. M	Satel.	
1	13. [illegible]	2	I
4	5. [illegible]	4	I
8	16. [illegible]	2	I
11	12. [illegible]	3	E
11	17. 4[illegible]	1	I
15	18. [illegible]	2	I
18	13. 1[illegible]	3	I
18	16. 4[illegible]	3	E
25	17. 1[illegible]	1	I
27	16. [illegible]	1	I

November

D.	H.M.	Satel.	
3	17.57	1	I
4	15.16	4	E
5	12.25	1	I
12	14.16	1	I
16	18. 8	2	I
19	16. 7	1	I
21	10.34	1	I
23	12.3[illegible]	3	E
26	17.47	1	E
27	9.54	2	I
28	12.24	1	I

December

D.	H.M.	Satel.
4	12.26	2
5	14.14	1
7	16.42	3
11	14.56	2
12	16. 4	1
14	10.32	1
18	7.28	2
19	17.54	1
21	12.21	1
23	16. 6	4
26	19.43	1
28	14.11	1
29	9.14	2

In this Table of the Eclipſes of *Jupiter*'s Satellites calculated for 1694. You are to note that the Eclipſes of the firſt Satellites are the moſt convenient for determining the difference of Longitudes of diſtant places; not only becauſe they happen more frequently, and may be diſtinctly ſeen with a good Teleſcope of 8, 10 or 12 foot long, but alſo becauſe its motion is found more regular.

The Eclipſes in this Table, are ſuch as are viſible in *England*, but to find when any other Eclipſe not viſible to us, but under ſome remote Meridian happens, you muſt firſt take the mean Revolutions of the Satellites, which are as follow.

	D	H	M	S
The mean Revol. of the firſt is made in	1.	18.	28.	36
of the Second in—	3.	13.	17.	54
of the Third in—	7.	03.	59.	36
of the Fourth in —	16.	18.	05.	03

Then to find when the next Eclipſe of the firſt Satellite will happen after *October* 4 1694. you muſt

To the given time of the Catalogue for *Oct.* 4. *viz.* 15 H. 54 M. add the time of one Revolution, *viz.* 1 D. 18 H. 28 M. 36 S. the Sum is 2 D. 14 H. 22 M. 36 S. which add to *Oct.* 4. makes *Oct.* 6. D. 14 H. 22 M. 36 S. *viz.* the time of the next Immerſion: and thus you may proceed for all the reſt, and by help of a Terreſtrial Globe rectified for the Latitude of *London*, and to the day of the month, you may find where any other Immerſion or Emerſion will be viſible.

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METHOD 4.

The methods hitherto declared for finding the true Longitude of places are not so universally useful as might be hoped, because they (depending upon Celestial Phænomena s) cannot always be put in practice. For not only a Cloudy Sky hinders our purpose, but many times the Eclipses of the Moon (happening in places far distant from us) are not to be observed by us; and sometimes also the Satellites of *Jupiter* (when that Planet is near the Rayes of the Sun, or when he is below the Horizon) are altogether unfit for our purpose. These inconveniencies have been endeavoured to be remedied by Automata's, or unerring Clocks: but what man will pretend to make a movement which shall always keep the same pace without any difference in motion; and were it possible to contrive so curious a piece of Clockwork, whose motion should be equal at all times in the place where it was made, yet experience tells us that tho a Clock goes just and regular in one place, yet it's motion will vary in another Country. For example: if its motion be certain and regular at *Lond.* it shall be uncertain at *Nova-Zembla*, and* the farther you advance within the Artic or Antartic Circles, towards either of the Poles, the motion shall be so much slower than at *London*, nay, the motion thereof shall be retarded, tho you increase the weight: and consequently when these Correct Automatons are carried into an air more warm than that in which they

* vide. Preface. -

they were made, their motion ſhall be ſwifter than before.

The reaſon whereof I will not determine, that is, whether theſe different degrees of motion in Clocks be imputable to the air, or to the figure of the Earth: but proceed to ſhew how (ſuppoſing ſuch Clocks to keep a juſt and regular motion in all parts of the Earth) the Longitude of places might be diſcovered by them.

When you depart from any place rectifie your Clock moſt accurately to that hour and minute of your departure, ſo ſhall your Clock ſhew you the true time for that place from whence you departed; then find the true time at that place to which you are come; (either by the Sun in the day, or by the Stars in the night) and by converting the hours and minutes (between theſe two times) into Degrees and Minutes, you have the difference of Longitude between the Meridian you firſt departed from, and the Meridian you are come into.

I have now done with the methods commonly made uſe of for finding the Longitude of places at Land: I wiſh any of them could be put in practice at Sea, that ſo Navigation might attain its deſired Perfection; however all my deſign in handling this matter ſo largely, is to give the Reader ſome certain Idea of the buſineſs of Longitude, and that there is no ſuch myſtery in this Notion, as our ordinary Seamen commonly imagine. And thus by knowing the Latitude and Longitude of any two places, we may readily conceive their poſition, or place upon the Superficies of the Globe.

CHAP.

CHAP. VIII.

The Description, Delineation and use of all Geographical Maps.

MAPS are the lively representation of the Position of Places: Of Maps, some are Spherical, and consequently universal; others Rectilinear, and generally particular: we will first begin with the Circular or Spherical Projection of Maps, as being most like to the Form or Figure of the Earth.

It is to be wondered at, that amongst so many as apply themselves to the study of Geography, there are but few to be found who throughly understand the Construction of Geographical Maps: for who can pretend to judge of conveniences or inconveniences of Maps, that are utterly ignorant of the foundations whereon they are placed. And seeing the whole skill of the construction of Maps depends upon the Principles of Opticks (commonly called Perspective) I shall here explain so much thereof as may be sufficient for our present purpose.

This Art of Perſpective teacheth us to repreſent all manner of Objects upon a Plain or Table in their true Site or Poſition; according as they appear to the Eye, howſoever it be poſited; which how to perform I ſhall here inſtruct You.

When we deſire to repreſent any Point, Superficies, or any Body in a Table (whether we really ſee them with our naked Eye, or ſuppoſe the Idea thereof in our mind) we ought firſt to ſuppoſe the viſible Object to be ſeen by one Eye, as from a Point: and to aſſign the Place, Site or Poſition of the Eye, from whence the Aſpect proceeds.

Secondly, in beholding any viſible Object, we ſuppoſe an infinite Plain, called the Glaſs or tranſparent medium to be placed between the Eye and the Object.

Thirdly, we ought to conceive, that from every Point of the Object there may be Rayes or Lines drawn (through this *Diaphanous* Medium) to the Eye, which Lines (ſo ſuppoſed) ſhall cut the Medium in certain points, and theſe points duly joyned by lines drawn from point to point, ſhall give the true repreſentation of the Object from that ſame ſight or poſition of the Eye. But this Optick contrivance holds not true in all Caſes, as may be eaſily conceived from the various poſitions of the interpoſed Medium; yet becauſe there is not hitherto a better way invented, we will content our ſelves with this for the preſent.

Thus then ſuppoſe the Earth with all it's Places upon the Periphery or Surface thereof were required

quired to be represented in *Plano*, and that the Eye be posited some where in the Aer.

Then between the Eye and the Object, let there be a supposititious transparent Plain; whose position (tho it may be taken at pleasure) to render the appearance of the Object more regular, we will suppose to be at right angles to that fictitious line which is conceived to be drawn from the Eye to the Center of the Earth: and from all the points in the Surface of the Earth, let us suppose lines to be drawn to the Eye; then shall these lines or visual Rayes cut this *Diaphanous* Plain in certain points, and these points duly joyned shall give the Representation of the Places in the Surface of the Earth: *Lastly*, if these Points in the Surface be all taken from any of the Circles of the Sphere, as from points in the Equator, Meridian, Tropics, *&c.* and be conjoyned by lines drawn from point to point, these connected lines (whether right or curved) shall be the Image, or Representation of that Circle, from whose Periphery they were drawn.

And by this Artifice may all the Circles of the Globe, and all the places in the Surface thereof be exactly represented.

And seeing the Earth is round, therefore the whole Surface of the Earth (with all the Places thereon) cannot be represented upon one Plane, because any two Places Diametrically opposite to each other, must be represented by one and the same point: so that if You desire a true Representation of all Places, You must do the same by two equal Hemispheres.

By

By this ſhort view of Perſpective, I hope the Reader can be able rationally to conceive how all the Surface of the Terraqueous Globe may be repreſented in *Plano*: and that nothing may appear wanting to his further Inſtruction, I ſhall explain theſe two following Particulars upon which the ſeveral varieties of Geographical Tables do depend.

Firſt, I told You that in drawing the Image or Repreſentation of any Object, there muſt be a point aſſigned for the poſition or Place of the Eye, which point ocular muſt alwayes be taken ſome where diſtant from the Object: then becauſe about any Object there is an infinite ſpace, and ſo there may be an infinite number of points from whence the Eye may view the Hemiſphere of the Earth; if from ſeveral of theſe infinite points there be Rayes or lines drawn to ſundry points in the Hemiſphere, (all which are ſuppoſed to paſs through the *Diaphanous* Medium) there ſhall ariſe ſundry various Repreſentations of this Hemiſphere, according to the different Situations or poſitions of the Eye.

Thus, when the Eye is directly poſited againſt the middle of any Frontiſpiece of an Houſe, the viſual Rayes drawn from each point in the Frontiſpiece (through the interpoſed *Diaphane*) to the Eye, make one kind of Image or Repreſentation thereof: and when the Eye is poſited either higher or lower; Obliquely to the right or left hand thereof, the Repreſentation is (at each of the Poſitions) different from the former.

And thus it is in the Repreſentation of the Hemiſphere of the Earth: for if the Eye be placed

placed in the air directly oppoſite to the Equator of the Earth, there will be produced one Repreſentation thereof: if poſited in the Axis, or Semiaxis, there will ariſe different Repreſentations; and hence it is, that in the Projection of the Sphere (which is only the Repreſentation thereof upon a Plain) the Equator, Meridians, Parallels, *&c.* have various and different Repreſentations.

Secondly, You muſt conſider the Cauſe of the Variety in the largeneſs of theſe Tables or Repreſentations.

The Superficies of the Earth, Churches, Houſes, *&c.* may be drawn or repreſented either in large, or in little. The Cauſe of which is twofold.

1. By how much the Eye is further diſtant from the Object, (the Poſition of the Diaphane remaining the ſame) by ſo much is the repreſentation of the Object leſſer.

2. By how much the Diaphane is poſited nearer to the Eye, the repreſentation or Projecture is leſſer, and the nearer this Diaphane is to the Object (the Eye remaining in the ſame poſition) the greater is the Repreſentation of the ſame.

But if the eye (the Diaphane remaining in the ſame Poſition) be removed any where, (provided it be in the ſame line with the Center of the Earth, or in any line perpendicular to the Surface of it) then the Figure of the Projecture i not changed, but the Size or Magnitude of the Figure is different. Alſo if the Table or Diaphane be removed any where either towards the Eye or the Object, then ſhall all the Projectures or Repreſentations be of different Magnitude,

tude, and yet all of them ſhall be like each other: that is, (in relation to the Projection of the Superficies of the Earth) all the Places ſhall have a like Poſition with that of the Prototype, provided that the Table in it's acceſſion to or receding from the Eye, keep in a parallel Poſition. But if the Table be not in a parallel Poſition, and the Eye be moved to any Oblique Poſition; all the projectures thence ariſing ſhall not be like; nor ſhall the Places in the Table, have the ſame Situation as in the Prototype, but ſhall be much different both in ſize and Similitude.

In the Projectures of all Bodies, as alſo in that of the Surface of the Earth, the Diaphane or Table is alwayes ſo to be poſited, that it may touch the Surface in that point, to which a right line drawn from the Eye is perpendicular to the Surface of the Earth: and for drawing the Projecture greater or leſſer, we muſt ſuppoſe the Eye to be moved further from or nearer to the Earth. But then we muſt admit the Earth to be very ſmall.

Thus having explained the nature of Projecting the Surface of the Earth, from whence the Original of all Geographical Charts is taken, we will enter upon the Methods of performing it. But firſt You muſt conſider whether all theſe Geographical Tables muſt be made according to the Rules of Perſpective, and whether they be ſo or not.

For the deſign of all Maps is to give a lively repreſentation of the Poſition of Places upon the Surface of the Earth; therefore we may not unfitly enquire whether this may not be effected without obſerving the Rules of Perſpective? For

whether these Maps be drawn according to the rules of Perſpective, or without any regard had to those Rules (provided that the Poſition of all Places be truly repreſented) then Maps ſo drawn are uſually ſaid to be well done. To this it may be anſwer'd, That ſmall Maps, *viz.* of ſome Province or the like may be projected by a Method different from the Rules of Perſpective, *viz.* by Angles of Poſition of Places, or by their mutual diſtances from one another: but all the Maps which contain a large portion of the Surface of the Earth, cannot more conveniently be performed, than by the Rules of Perſpective, commonly called the Projection of the Sphere.

In the Projection of Maps, there are theſe things to be conſidered. Firſt, that all Places have the ſame Situation in Your Maps, as they have upon the Globe it ſelf, that is, that they may be under the ſame Meridians, Parallels, and diſtance from the Equator in Your Map, as they are from the Equator of the Earth. *Secondly*, the Extenſion of all Country's upon Your Maps, have the ſame Proportion as on the Earth it ſelf, and *Thirdly*, that all Places have the ſame ſituation and diſtance one from another, as they have upon the Surface of the Earth.

The firſt of theſe three Conſiderations may be exactly performed by help of a Table of Latitude and Longitude of Places: the ſecond cannot ſo accurately be done if we follow the Rules of Perſpective, becauſe thoſe parts of a Curved Surface which are more remote from the Eye, do make a leſſer Repreſentation in the Diaphane; than thoſe which are nearer to it; but this Inequality

quality is ſmall and inſenſible, if the Eye be ſuppoſed to be of an infinite diſtance from the Earth. And as to the third Conſideration, I ſay that all large Maps, as thoſe of the whole Earth, and thoſe of the four Parts thereof cannot perform the Buſineſs exactly, altho' in ſmall Maps this Third Conſideration may in ſome meaſure be effected: this Explication being rightly underſtood, we come to put theſe precepts in practice.

Firſt, to draw a Map of the World, from the Poſition of the Eye in the Axis thereof.

FIG. 28.

LET it be required to draw the Meridians and Parallels of a Map, which ſhall contain $\frac{1}{2}$ of the Surface of the Earth, *viz.* that Hemiſphere which is contained beween the Equator and the North or South Poles of the World.

For the effecting whereof, let us ſuppoſe the Eye to be placed ſome where above the Hemiſphere, exactly over the middle point thereof, which repreſents one of the Poles of the World, ſo ſhall the Eye, the Pole, and Axis of the World be all three in one direct line; and ſo ſhall the Plain of the Equator or that Plain (parallel to it) which toucheth the Hemiſphere in the Pole point, repreſent the Diaphane, or tranſparent Medium.

Then let us ſuppoſe that from all the Places or points in the Peripherie of the Hemiſphere there are lines drawn to the Eye cutting his Dia-

phane in ſeveral points, which points duly joyned ſhall give the Image or Repreſentation of the Hemiſphere : Thus if You take ſeveral points in the Diaphane, which ariſe from the lines drawn from ſeveral points in the Tropic to the Eye, theſe lines will when duly joyned repreſent the Periphery of the Tropic. And in this method, it is evident that the Equator is the Term of Projection : and that the Pole of the Earth is Repreſented by the Centre of this Circle, or Equator : that the Meridians (all paſſing through the Pole of the World even to the Equator) are all ſtreight lines ; and that all Parallels of Latitude, Tropics, Polars, *&c.* do by this way of Projection, become Circles, whoſe common Centre is the Pole of the World.

And ſeeing that the Longitude and Latitude of any Place is determined by the interſection of the Meridian and Parallel of that Place, therefore at the interſection of the Meridians and Parallels in the Optic Hemiſphere may the Longitudes and Latitudes of Places be truly repreſented upon this Projection. All other Peripheries and Semiperipheries which have not the Pole of the World for their Centre, and are to be drawn upon this Hemiſphere, are not right lines, nor Circles, but Ellipſes

For if it be required to draw the Horizon of any Place and any of the vertical Circles there, they muſt be drawn almoſt like Arches of an Ellipſis ; for when a Circle is ſeen from any oblique Poſition of the Eye, it can never appear like unto an Ellipſis : the reaſon whereof is this, that in an Ellipſis, tho' the two Diameters be unequal, yet

yet the two Semidiameters, I mean the two Semidiameters of the Conjugate, or Tranſverſe Diameters are equal; but in the Optic Projection of a Circle, the two Semidiameters of theſe two Diameters are unequal.

For the clearer underſtanding of this kind of Projection we muſt ſuppoſe there is an Optic round Pyramid, uſually called a Cone, whoſe vertex reacheth to the Center of the Eye, and whoſe Baſe is that Circle of the Earth which is required to be projected; the Sides of this Cone are Rayes drawn from the Periphery of the Circle to the projected, and continued to the Eye. We muſt alſo ſuppoſe this fictitious Cone to be cut by the Diaphane or tranſparent Medium: and according to the different poſition thereof there ariſeth a different Section and line, which is the projecture of the given Circle. Thus the Ecliptic it ſelf, $\frac{1}{2}$ whereof is contained under the Artic Hemiſphere, the other $\frac{1}{2}$ under the Antartic, muſt be projected like as a part of an Ellipſis. Having now ſufficiently explained the Method of theſe kind of Maps, I ſhall proceed to the Projection thereof.

FIG. 28.

Let P the middle point repreſent the Pole of the World; from whence as from a Center let there be deſcribed a Circle of what Radius you pleaſe, which ſhall repreſent the Equator; and from this Center and the Circumference from thence deſcribed, are all other points to be taken. Divide this outward Circle into 360°. 00′. ſo

ſhall right lines drawn from the Pole and paſſing through theſe points, repreſent Meridians, and that Meridian which paſſeth through the beginning of the firſt Degree ſhall be taken for the firſt Meridian, and ſo ſhall the other lines repreſent the remaining Meridians of the Earth, and Longitudes from the firſt Meridian. But in this Chart it is ſufficient to expreſs only every 10*th.* Meridian, as You ſee in the Figure, P.10. P.20. P.30. *&c.* in the Quadrant AB.

To delineate the Parallels of Latitude, lay a Ruler on D and on each 10*th* Degree in the Quadrant BC, and draw lines as you ſee in the Figure, which ſhall cut the Diameter AC in 10. 20. 30. *&c.* then from P with the diſtance P.10.P.20. *&c.* ſtrike the Circles, which ſhall repreſent the Parallels of Latitude required.

Then becauſe the Tropics are 23°. 30′ diſtant from the Equator, and the Polar Circles 23°. 30′ from the Poles, therefore to deſcribe theſe two Parallels ſet 23°. 30′ from A to E, and draw DE to cut AC in G: from P with the diſtance PG ſtrike a Circle which ſhall repreſent the Tropic of Cancer. Alſo ſet 23°. 30′ from B to H a Ruler on DH will cut the line AC in I. from I with the diſtance PI ſtrike a Circle, which ſhall repreſent the Artic Circle.

The Meridians and Parallels being thus drawn, by help of a Table of the Latitude and Longitude of Places, we may inſert the Places themſelves into the Map. Thus, from the firſt Meridian, count in the Equator the Longitude of the place you deſire to expreſs in the Map; ſo ſhall you thereby find the Meridian of that Place; then

amongſt

amongſt the Parallels find the Latitude of that Place, and in that point where the Meridian cuts the Latitude, is the place to be put, the name whereof ought to be alſo expreſt.

To project the Semicircle of the Ecliptic we muſt find three points through which the Ambit of the Ecliptic muſt paſs: the firſt point is at Interſection of the firſt Meridian with the E uator, at A: the ſecond point is at the interſection of the ſame, 180°. diſtant from the former at C, and the middle point is that in which the Meridian cuts the Tropic of Cancer, *viz.* at K. thus have we three points A. K. C. through which muſt be drawn that portion of the Ellipſis required, and is leſs than ½ the Ellipſis: but theſe three points do paſs through the beginning of Aries, the beginning of Cancer, and the beginning of *Libra*; then we muſt find the firſt point of *Taurus*, *Gemini*, *Leo*, *Virgo*, through which the Ecliptic muſt alſo paſs: but the greater number of points we have given in the Ambit of an Ellipſis, the more accurately may the Figure be drawn; therefore let us take every 15*th*, Degree of the Ecliptic, and by the following Table of the Sun's Right Aſcenſion and Declination, find the right Aſcenſion and Declination for the 15*th*, and 30*th*, of *Aries*, *Taurus*, *Gemini*, &c. which from the aforeſaid Table will appear to be as follow — *viz.*

	Right Ascension. D.	M	Declination. D.	M
Aries 15	13.	48	5.	56
Taurus 0	27.	54	11.	30
Taurus 15	42.	31	16.	23
Gemini 0	57.	48	20.	12
Gemini 15	73.	43	22.	39
Cancer 0	90.	00	23.	30
Cancer 15	106.	17	22.	39
Leo 0	122.	12	20.	12
Leo 15	137.	29	16.	23
Virgo 0	152.	06	11.	30
Virgo 15	166.	12	5.	56

Then in the Equator find these Degrees of Right Ascension, and from P the Pole of the World draw lines to each of the respective Degrees; Lastly, from the graduated Semidiameter AC, take the responding declinations, which applyed to these lines, will give you a competent number of Points through which the Ambit of the Elliptic Segment must be drawn, then joyn these points by a neat arching line, so have you projected the Hemisphere of the Ecliptic.

So have I compleated the projecture of one Hemisphere of the Globe, and the other Hemisphere (like to this in every part) must be effected in the same manner.

Now having discoursed of the projection of this sort of Maps, we will enquire into the use thereof, and whether or no it be clogged with inconveniences.

Th is

This Map does exactly ſhew the Latitudes and Longitudes of Places, alſo the diſtance of places from any of the Zones; but the due proportion of the Magnitudes of Countries it does not rightly exhibit; becauſe thoſe Countries which are near to the Equator do receive a larger projection than thoſe that are more remote from it. But this defect has one convenience attends it, *viz.* that Places may be more diſtinctly inſerted, and that there are but a few Places habitable near the Pole, whereas near the Equator there are many.

Note, That a right line drawn between any two Places upon theſe Maps, will repreſent an Arch of a great Circle, paſſing over the Zenith of theſe two Places; and alſo will exactly ſhew the Latitude and Longitude of all Places over which it paſſeth, even as upon the Globe it ſelf; but the Poſition and Diſtance of Places from one another cannot be found by them.

Secondly, To draw a Map of the World from the poſition of the Eye in the Plane of the Equator.

FIG. 29.

THE foregoing Method of the Conſtruction of Maps lying under ſo many inconveniences, as the unequal proportion and ſituation of places; the difficulty of conceiving the Pole of the World to fall in the Centre thereof, *&c.* I ſhall ſubſtitute another way far more agreeable and uſeful.

For the true and perfect apprehenſion of this Method,

Method, we muſt conceive the Superficies of the Earth to be cut into two Hemiſpheres by the Periphery of the firſt Meridian; the Eye muſt be poſited in a point of the Equator 90 Degrees diſtant from the firſt Meridian: the Diaphane or tranſparent Medium in which the repreſentation is to be made, we ſuppoſe to be the Plane of the firſt Meridian: Laſtly, that Hemiſphere, which in reſpect of our Eye lies below that Plane, is ſaid to be repreſented in that Plane.

In this projection of the Superficies of the Earth the Semicircle of the Equator is become a right line: and that Meridian which is 90°. 00′ diſtant from the firſt, and in which the Eye is ſuppoſed to be poſited, muſt likewiſe be repreſented by a right line: but the other Meridians, and all the parallels of the Equator, become Arches of Circles.

The Conſtruction.

Upon E (as a Centre) with any extent, deſcribe a Circle which ſhall repreſent the firſt Meridian, as ABCD, and the line BED ſhall repreſent that Meridian which is 90°. 00′. diſtant from it: alſo B repreſents one of the Poles of the World, and D the other: the Diameter AC, at right-angles to BD, repreſents the Equator, and E the point of the Eyes poſition. Thus we have the firſt Meridian divided into 4 Quadrants, *viz.* AB. BC. CD. DA. each of which quadrants muſt be divided into 90°. 00′.

Firſt, the line AC, repreſenting half the Equator muſt be dvided into 180 degrees, after this manner

manner, lay a Ruler upon D, and upon each Degree, (or rather each 10*th* Degree) in the Quadrant AB. ſo ſhall the ſide of this Ruler cut the Quadrant of the Equator A E in H. I. K. L. M. N O. P: and in like manner may the other Quadrant of the Equator be divided. This Diviſion of the Equator, is the ſame with the Diviſions upon a line of half Tangents, and the Arch EP is the half Tangent of 10°. EO of 20°. EN of 30°. &c. But if DE be the Radius of a Circle, then EP will be the Tangent of 5°. EO the tangent of 10°. and EA the tangent of 45°. 00'. for by 20. 3. *Euclid*, an angle at the Center VEB is double to an angle at the Circumference VDB; therefore having the two Poles, and the Points H. I. K. L. &c. given, we may deſcribe the Circumference of a Circle which ſhall paſs through theſe points, and the Circumference ſo deſcribed ſhall repreſent the Meridians of this Chart. Thus, ſuppoſe the Center of the Meridian BHD, (paſſing through the firſt 10°. of Longitude) be required. Seek in the line EC, for the Tangent of 10° which is at Q. ſo ſhall Q. be the Center required; then from Q ſtrike the Meridian BHD. from R. the Meridian BKD. &c. and after this manner may all the Meridians be deſcribed; and the Centers of all thoſe Meridians, whoſe diſtance from the firſt Meridian BAD is leſs than 45°. may be found in the line EC: or AE; but the Centers of thoſe which are more than 45°. diſtant from BAD muſt be found in the lines EC, AE continued thus, the Center of the Meridian BMD, 50°. diſtant from BAD, may be found by laying a ruler on B and W to

W to cut EC (continued) in X. So ſhall X be the Center from whence the Meridian BMC muſt be drawn. The reaſon whereof is evident from the Figure, for if BE be the Radius of the Circle, and from B be deſcribed an Arch with that Radius, and upon this Arch you ſet 50°. then a line from B through the term of this Arch will cut the Circle in W, and the Diameter AC (continued) in X. The ſame alſo may be done by counting each 20 degrees in the Quadrant DC for 10°. So ſhall the whole DC, contain 45°. to which add CW 5°. and the Arch DW will be 50°. whoſe Tangent is EX, the like is to be underſtood of all the reſt.

The conſtruction of the Parallels of Latitude is thus: Divide the Quadrants of the Meridian BED after the ſame manner as you divided the Diameter AC, or which is all one, transfer the Diviſions in AE into the line EB. ED. then the Centers of all the Parallels, Tropics and Polars will fall in the line EB continued; and theſe points or Centers may be diſcovered as followeth, *viz.*

Upon C the end of the Diameter, erect a Perpendicular Cc. which ſhall be a Tangent line unto the primitive Circle: from E through each Degree in the Quadrant BC draw lines, as EW. EY. EZ. Ea. Eb. &c. and in this Tangent line Cc ſo divided may be found the Center of all the Meridians, for CW. ſhall be equal to EQ: CY to ER: CZ to ES, &c.

Alſo all thoſe lines drawn from the Center E through each degree in the Quadrant Bc ſhall be Secants, as EW is the Secant of the firſt 10 degrees

grees, which applyed from E upon the line EB ſhall give the Center of the parallel V 80 V: EY transferred into EC ſhall give the Center of the parallel d 70 d, and EZ applyed as afore, ſhall give the Center of the parallel e 60 e. the like is to be underſtood of all the reſt.

And after this manner were the Polar Circles and Tropics deſcribed, as you ſee in the Figure.

There are two different methods of deſcribing the Ecliptic by this projection, according as you deſign the ſituation thereof either upon, or above the Earth, ſo that its Interſection with the Equator may paſs through the point E, which is the firſt point of *Aries*; and in this poſition the projecture of the Semicircle of the Ecliptic, *viz.* from the beginning of *Cancer*, to the beginning of *Capricorn*, is a right line: and becauſe the greateſt diſtance of the Ecliptic from the Equator is 23°. 30′. therefore from this point draw the line FEG to repreſent the Semicircle of the Ecliptic according to this method: and if you divide this line FG as you did the Equator AC, you may number upon it the Degrees of each Sign.

But if you deſign the Interſection of the Meridian and Equator to be at A in the firſt Meridian, then the projection thereof becomes a portion of an Ellipſis, whoſe two points are A. C. and the third is that in which the Meridian BED cuts the Tropic of *Cancer*, *viz.* at E, the other intermediate points, through which the Ecliptic muſt paſs, may be found according to the directions in the preceding method of projecting the Sphere, *viz.* by the right Aſcenſions

ſions and Declinations of each 15*th* Degree in the Ecliptic. After this way is the Ecliptic uſually projected upon ſuch Maps as are drawn upon two equal Hemiſpheres, one Semicircle thereof being drawn in the one, and the other Semicircle, in the other Hemiſphere.

The projection being thus compleated, the known Latitudes and Longitudes of places may eaſily be inſerted therein for that point where the Parallel of the Latitude of any place cuts the Meridian of Longitude of the ſame place, is the true repreſentation thereof.

By this artifice alſo may the whole Surface of the Earth be exhibited in one Map, if inſtead of the place of the firſt Meridian, you ſubſtitute another Plane parallel to it, and the poſition of the eye be very near this ſubſtituted Plane, which in this caſe muſt repreſent the Diaphane or tranſparent Medium: for ſo the Parallels and Meridians may be continued, whereas now they do not exceed a Semicircle: but then the repreſentation would be much different from the true Surface of the Earth: and its uſe appearing far more convenient for determining all hour-diſtances upon Dyal-Plains, than for Geography, I omit to explain it further.

The uſe of this kind of Projection, I mean in meaſuring the poſitions and diſtances of places cannot conveniently be determined by theſe Maps, unleſs one of the places be poſited under the firſt Meridian, which how to perform, I may perhaps hereafter give ſome particular Rules, in an abſolute Projection of the Sphere.

I have

I have now explained (so far as my present design required) the construction of some Circular Maps or Charts, according to the rules of Perspective, I proceed to the construction of right-lined Maps, which for Sea purposes are far more convenient than the former.

Of Right-lined Maps.

Right-lined Maps are such whose Meridians and Parallels are all right lines: and consequently (according to the Rules of Optics) cannot give an express Image of the Prototype; for there can be no position of the eye, or medium, wherein both these Species of Circles, *viz.* the Meridians and Parallels can become right lines.

In Figure the 28*th* it was demonstrated that the Meridians were all of them right lines, and that by Rules of Perspective: and in the same place it appears that the Parallels of Latitude are all of them Circles, not right lines. Charts of different construction from those I have here explained may be made, but then altho the Parallels of Latitude be right lines, the Meridians will become Elliptical. Others may have their Meridians right lines; but then the Parallels will be Hyperbola's, *viz.* when the eye is posited in the Center of the Earth, and views an Hemisphere from either part of the first Meridian; the transparent medium through which the visual Rayes pass from the Object to the eye, being a plain parallel to the first Meridian: and all these several kinds are drawn by Rules of Perspective, but all those

those Maps whose Meridians and Parallels are right lines, their Construction does oppose these Rules.

Of these there are two Kinds. One of them consisting upon this Hypothesis, *viz.* that the Degrees of Latitude, and Longitude in every part are equal one to another. The other of them making the Degrees of Longitude in all Places, equal one to another, but the Degrees of Latitude unequal. The Degrees of Latitude encreasing continually from the Equator to the Poles, so that in the Latitude of 60°. 00′. one Degree in the Meridian is equal to two Degrees of the Equator, in the Latitude of 80°. to 5°. thereof, and in the Degrees of the Meridian near to the Poles, are almost infinite. The first of these is commonly called the Plain Chart, which as I told You before, took it's Original from that erroneous Notion of the Ancients, *viz.* that the form of the Earth was like to a large extended Circular Plain, as that of a Round Table, founded upon a Basis infinitely continued downwards; hence Charts or Maps delineated according to this Hypothesis are usually called Plain. By this Chart, it is evident that all North and South lines drawn thereupon cannot pass through the Poles of the World. And therefore cannot truly be called Meridians, Also by this it appears that each Parallel of Latitude is equal to the Equator. How disagreeable this Hypothesis is, and how repugnant to Reason, may be thus apprehended.

If the Form of the Earth and Sea be a large extended circular Plain, then at the verge or Limits thereof must be a Precipice impassable. But our

our Ship's having Sailed over moſt parts of the Sea, *viz.* from North to South, and by continuing an Eaſtward Courſe have arrived at the ſame Place from whence they began to ſail, without diſcovering any ſuch Precipice; therefore I ſay that Hypotheſis is contrary to experience: and that the ſame is repugnant to reaſon, may thus be argued. If the Earth be ſuſtained upon a Baſis infinitely continued downwards, this Baſis muſt not only reach to the Heavens, but likewiſe paſs through them; and ſo proceed to infinity, but this Baſis as they called it, muſt be viſible in the time of the Lunar Eclipſis, for the ſhadow of the Earth reacheth thither, and ſure the ſhadow of this infinitely long handle, muſt at thoſe times be viſible or apparent to us; but this hath hitherto been inviſible: *Ergo*, no ſuch thing in nature. A great number of Arguments may be produced to break down this long Pedeſtal, which I forbear to mention, hopeing my Reader will rather in ſuch Caſes make uſe of his own reaſon in enquiring the truth, than pin his Faith on the Sleeve of Antiquity.

And tho' this Chart depend upon a falſe ſuppoſition, yet ſeeing our Seamen are not willing to lay aſide the practice of their Fore-Fathers in continuing the uſe of this Chart, I ſhall firſt ſhew it's Conſtruction, and then proceed to the uſe thereof.

The Construction of the Plain Chart.

FIG. 29.

These Charts are either general or particular; and the construction of either of them is as follows.

Draw the line AB for the Equator in a general Chart; divide this line into 180 equal parts or Degrees, and through each Degree, or each 10*th* Degree draw perpendicular lines, which shall represent the Meridians of this Chart. Divide these Meridians into 90 equal parts or Degrees, beginning that Division at the Equator AB, and proceeding from thence both to the Northward and the Southward thereof,each division in the Meridian being equal to each in the Equator, then through each 10*th* Degree in the Meridian, draw lines Parallel to the Equator, which shall represent the parallels or Circles of Latitude, as the Meridian did represent the Circles of Longitude.

Lastly, because the World (according to this Hypothesis) is a Circular plain, therefore from C strike the Circle ADBE, which shall represent the Figure of the Earth with all its Meridians and Parallels contained therein. Upon this Chart you may (by help of a Table of Latitude and Longitude of places) insert the said places.

But seeing (according to this Chart) that the Meridians have no inclination one to another, but are all parallel to each other,and divided equally as is the Equator, therefore if you insert these places according to their true Latitudes and Longitudes, them

then ſhall their Courſe and Diſtance diſagree with the Globe; and if you ſet theſe places upon this Chart according to their Latitude and Diſtance, then will their Courſe be true, but their Longitude always erroneous, as ſhall be explained in the uſe of the True Sea Chart.

The Conſtruction of the particular plain Chart is the ſame with that of the general, as you may ſee in Fig. 33. where every Degree of Latitude is equal to each Degree of Longitude, and differs only in it's extent from that of the general.

The other ſort of right Lined Maps which (for the perpetual reputation of the firſt inventer, our famous Countryman Mr. *Edward Wright*) ought to be called *Wright*'s Charts, and not *Mercator*'s, who only ſtole the Invention from the Author, and publiſhed them in his own Name, thoſe Charts do (as the former) divide the Equator into equal parts called Degrees; and have all the Meridians at right Angles to the Parallels of Latitude, but the diviſion of the Meridians (by the Circles of Latitude) are much different from the diviſion of the Meridians in the plain Chart. For, the degrees of the Meridian are not equal but unequal, as I noted before; and do continually encreaſe from the Equator towards both the Poles.

This curious contrivance, the Ingenious Author thereof endeavoured to accompliſh upon this very occaſion, *viz.* He conſidered how all other Maps, whoſe Conſtruction depended upon the Optic projection of the Sphere, were (even the beſt of them) unfit for the uſe of ordinary Seamen,

for tho' the Latitude and Longitude of Places might be truly laid down upon them, yet the bearing and diſtance of Places, (being of greateſt uſe to Seamen) could not poſſibly be found in ſome of them; and not without much labour and Art, in others of them: and thereupon he applyed himſelf to the diſcovery of ſuch a Conſtruction, as might not only ſhew the Latitude and Longitude of Places, but alſo their bearing and diſtance, in right Lines.

The Conſtruction is as followeth.

FIG. 70.

The Meridians (through every degree of the Equator) are drawn mutually parallel, and all the Circles of Latitude parallel to each other, and alſo to the Equator, the degrees of the Meridians encreaſing continually from the Equator; hence it is, that Places poſited in every of the Meridians, are removed ſo much farther above their true diſtance from the firſt Meridian, by how much they are more remote from the Equator. That is, that in theſe Charts, the diſtance of Places from the firſt Meridian, does ſo much exceed the juſt diſtance, as the Semidiameter of the Earth, exceeds the Semidiameter of any Parallel; or as the whole Sine exceeds the Sine Complement of any Parallel of Latitude. And what proportion the whole Sine (or Radius of the Earth) bears to the Co-Sine of the Latitude of any Place, the ſame proportion does one Degree in the Equator bear to one Degree in a Circle of that Latitude or Parallel.

It

It appears from the Globe, that a degree in any Parallel is leſs than a degree in the Equator; and that degrees in each Parallel do grow leſs and leſs, according as that Parallel is nearer to the Poles, as you may obſerve in Fig. 30. but in this admirable Contrivance, the Parallels of Latitude are each made equal to the Equator, and conſequently a degree in each Parallel muſt be equal to a degree in the Equator: therefore by how much the Parallels themſelves are encreaſed above the juſt extenſion, by ſo much muſt the Meridians be encreaſed above the extenſion of the Equator, and by Figure 58. the proportion of any Parallel to the Equator, and of a degree in any Parallel to a degree in the Equator may be found: for let ÆQ be the Equator NP. SP the North and South Poles of the World, and ADB any Parallel of Latitude; then it is evident that ÆC is the Semidiameter of the Equator, and AD the Semidiameter of the given Parallel; therefore, as ÆC is to AD, ſo is CE a degree in the Equator, to DF a degree in that Parallel: and the contrary; for AD bears ſuch proportion to ÆC as DF doth to EC.

Here, note that if you deſire the proportion more accurately, you muſt not take the Sine of the Complement of the Latitude of any Parallel, but the ſine of the Complement of the Latitude which begins at that degree, muſt be added to the Sine of the Complement of that Latitude which terminates that degree, and the half of this Sum muſt be the firſt term in the Rule of proportion.

EXAMPLE 1.

Suppose it be required to find a Point in the Meridian which shall answer to the first degree of Latitude, let the quantity of one degree in the Equator contain 60 parts, (which elsewhere I call Sexagenary miles)

According to the first proportion the Quantity of a degree in the Meridian for the first degree of Latitude, will be equal to a degree of the Equator, because the Equator it self is the Parallel which begins that degree: but according to the second proportion I take the Co-Sine of 00°. 00′ of Latitude which is the Sine of 90°. 00. *viz.* 100000, (for the Complement of 00°. to 90°. is 90 degrees) and I add it to the Sine of the Complement of 1°. 00′ *viz.* to the Sine of 89°. 00′, which is 99985, the Sum is 199985, and the $\frac{1}{2}$ Sum is 99992: therefore as 99992 is to 100000, so is 60 the quantity of one degree at the Equator to 60 $\frac{480}{99992}$ the quantity of a degree in the Meridian for the first degree of Latitude.

EXAMPLE 2

Let it be required to find the length of a degree in the Meridian for the Latitude of 60°. 00′ this Parallel of 60°. is bounded by the Parallel of 59°. on one Side, and by the Parallel of 61° on the other Side. Then by the first of the preceding Proportions the Sine of the Complement of 59°. 00′, is 51503, therefore as 51503 is to 100000, so is 60 to 116 $\frac{17152}{51503}$ for the quantity of a degree in the Latitude of 60°. 00′.

Bu

But according to the ſecond proportion, you muſt look for the Sine of the Complement of 59°. which is 51503. and alſo for the Co-Sine of 61°. which is 48481. the Sum of theſe two Numbers is 99984. and the half Sum is 49992, therefore ſay

As 49992 is to 100000 ſo is 60 to 120 $\frac{960}{49992}$ the juſt quantity of a degree in the Meridian for the Latitude of 60°. 00′.

And thus when you have found the quantity of a degree for the Parallel of 2°. 00′, you muſt add it to the quantity of a degree for the Parallel of 1°. 00′ and the Sum ſhall give the true point in the Meridian through which the Parallel of 2° from the Equator. Again having found the quantity of a degree for the Parallel of 3°. 00′ add the ſame to the Sum of the quantities of 1°. and 2°. and this aggregate ſhall ſhew the term in the Meridian through which this third degree of Latitude muſt paſs.

By this you may eaſily underſtand how the Meridian line muſt be encreaſed for the Equator towards the Poles, only by help of a Table of Natural Sines; and how to performe the ſame by a Table of Natural Secants (which is the method uſed by Mr. *Wright*) may be apprehended from this univerſal Theorem, *viz.*

Radius is a mean proportional between the Sine of an Arch, and the Secant of the Complement of the same Arch.

FIG. 10.

Demonſtr. the Triangles CFK, CDH are like or equiangular, becauſe of the two Parallel lines CK. DH; and by Theor. 2. 3. Chap. 6. the angle CFK is equal to the angle DCH. therefore by 2. 6. *Euclid*, as KF is to CF. ſo is CD to CH. but CD is equal to CF the Radius of the Circle, KF is the Sine of the Arch BF. and CH is the Secant of the arch DF, the Complement of BF to a Quadrant, and therefore alternately, as HC. FC : : FC. FK. which was to be demonſtrated.

Hence it appears, that ſeeing the Semidiameter of each Parallel is made equal to the Semidiameter of the Equator, the Meridian at each point of Latitude muſt needs encreaſe by the ſame proportion wherewith the Secants of the Arches contained between the points of Latitude and the Equator do encreaſe.

Thus both by the Table of Natural Sines, or Natural Secants, may the diviſions of the Meridian line be expedited. For, firſt find the Secant of 1 degree of Latitude from the Equator, this ſhall give you the Section in the Meridian through which the firſt degree of Latitude muſt be drawn; then find the Secant of two degrees, which being added to the Secant of 1 degree, the Sum ſhall be the Section on the Meridian, through which the Parallel of 2 degrees muſt

muſt paſs. Again, find the Secant of 3 degrees, this added to the Sum of the Secants of 1°. and 2°. the Aggregrate ſhews the Section or point of the Meridian through which the Parallel of 3 degrees of Latitude muſt paſs. The ſame you muſt underſtand of all the reſt.

But to render the Idea of this contrivance more perceptible, I ſhall uſe the Author's own Illuſtration which is as followeth, *viz.* If a Globe be with all it's Meridians and Parallels poſited in a Concave Cylinder, (their Axes mutually agreeing) be ſuppoſed to be blown like a Bladder till every part of the convex ſuperficies of the Globe touch every part of the concave Cylinder, then ſhall each Parallel upon the Globe attain an equal Diameter with the Equator or Cylinder: and then ſhall the Meridians upon the Globe, be every where ſo far diſtant each from other, as they were at the Equator; and by this contrivance will each part in this Concave Cylinder, mutually agree with it's correſponding part in the Globe, without either ſenſible or explicable Errour.

For the Delineation of theſe Charts you muſt proceed thus. By the continual addition of Secants, you have a Table of Meridional parts, the Secants beginning at the Equator or Parallel of 00°. 00'. and continuing ſucceſſively to the Poles, that is equally alike on both Sides of the Equator: one degree of Longitude, or of the Equator being taken for the Radius of that Circle, whoſe Secant ſhew the points of diviſion in the Meridian Line.

The readieſt method for drawing the Parallels of Latitude in thoſe Charts is by help of a line of Secants

Secants upon a Sector, for making one degree of Longitude in the Equator, (which you may take of what length you pleaſe) the Radius of a Circle, rectify the firſt points of the Secants upon your Sector, to that diſtance, ſo ſhall each degree upon your Sector give you the quantity of each degree of Latitude in the Meridian line, as I ſhall farther explain in the uſe of this Chart.

A

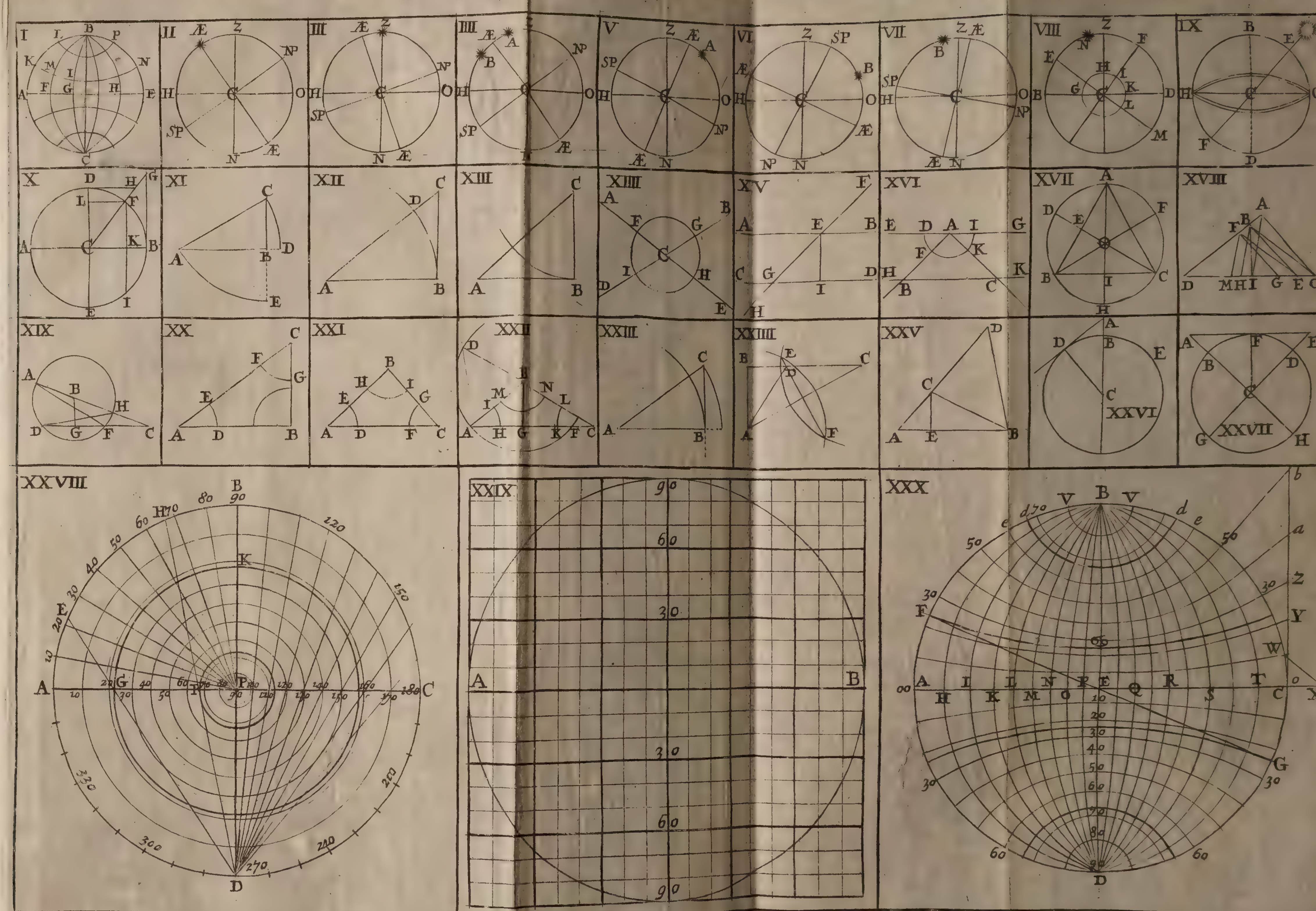

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TABLE

OF

MERIDIONAL PARTS

To every Minute of the

QUADRANT.

Degrees of Latitude.

M.	0	1	2	3	4	5	6
0	0	60	120	180	240	300	360
1	1	61	21	81	41	01	61
2	2	62	22	82	42	02	62
3	3	63	23	83	43	03	63
4	4	64	24	84	44	04	64
5	5	65	125	185	245	305	365
6	6	66	26	86	46	06	66
7	7	67	27	87	47	07	67
8	8	68	28	88	48	08	68
9	9	69	29	89	49	09	69
10	10	70	130	190	250	310	370
11	11	71	31	91	51	11	71
12	12	72	32	92	52	12	72
13	13	73	33	93	53	13	73
14	14	74	34	94	54	14	74
15	15	75	135	195	255	315	375
16	16	76	36	96	56	16	76
17	17	77	37	97	57	17	77
18	18	78	38	98	58	18	78
19	19	79	39	99	59	19	79
20	20	80	140	200	260	320	380
21	21	81	41	01	61	21	81
22	22	82	42	02	62	22	82
23	23	83	43	03	63	23	83
24	24	84	44	04	64	24	84
25	25	85	145	205	265	325	385
26	26	86	46	06	66	26	86
27	27	87	47	07	67	27	87
28	28	88	48	08	68	28	88
29	29	89	49	09	69	29	90

Degrees of Latitude.

M	0	1	2	3	4	5	6
30	30	90	150	210	270	330	390
31	31	91	51	11	71	31	91
32	32	92	52	12	72	32	92
33	33	93	53	13	73	33	93
34	34	94	54	14	74	34	94
35	35	95	155	215	75	335	195
36	36	96	56	16	76	36	96
37	37	97	57	17	77	37	97
38	38	98	58	18	78	38	98
39	39	99	59	19	79	39	99
40	40	100	160	220	280	340	400
41	41	01	61	21	81	41	01
42	42	02	62	22	82	42	02
43	43	03	63	23	83	43	03
44	44	04	64	24	84	44	04
45	45	105	165	225	285	345	405
46	46	06	66	26	86	46	06
47	47	07	67	27	87	47	07
48	48	08	68	28	88	48	08
49	49	09	69	29	89	49	09
50	50	110	170	230	290	350	410
51	51	11	71	31	91	51	11
52	52	12	72	32	92	52	12
53	53	13	73	33	93	53	13
54	54	14	74	34	94	54	14
55	55	115	175	235	295	355	415
56	56	16	76	36	96	56	16
57	57	17	77	37	97	57	17
58	58	18	78	38	98	58	18
59	59	19	79	39	99	59	[illegible]

Degrees of Latitude.

M.	7	8	9	10	11	12	13
0	421	481	542	603	664	725	786
1	22	82	43	04	65	26	87
2	23	83	44	05	66	27	88
3	24	84	45	06	67	28	89
4	25	85	46	07	68	29	90
5	426	486	547	608	669	730	791
6	27	87	48	09	70	31	92
7	28	88	49	10	71	32	93
8	29	89	50	11	72	33	94
9	30	90	51	12	73	34	95
10	431	491	552	613	674	735	797
11	32	92	53	14	75	36	98
12	33	93	54	15	76	37	99
13	34	94	55	16	77	38	800
14	35	95	56	17	78	39	01
15	436	496	557	618	679	740	802
16	37	97	58	19	80	41	03
17	38	98	59	20	81	42	04
18	39	99	60	21	82	43	05
19	40	500	61	22	83	44	06
20	441	01	562	623	684	745	807
21	42	02	63	24	85	46	08
22	43	03	64	25	86	47	09
23	44	04	65	26	87	48	10
24	45	05	66	27	88	49	11
25	446	506	567	628	689	750	812
26	47	07	68	29	90	51	13
27	48	08	69	30	91	52	14
28	49	09	70	31	92	53	15
29	50	10	71	32	93	54	16

Degrees of Latitude.

M.	7	8	9	10	11	12	13
30	451	511	572	633	694	755	817
31	52	12	73	34	95	57	18
32	53	13	74	35	96	58	19
33	54	14	75	36	97	59	20
34	55	15	76	37	98	60	21
35	456	516	577	638	699	761	822
36	57	17	78	39	700	62	23
37	58	18	79	40	01	63	24
38	59	19	80	41	02	64	25
39	60	20	81	42	03	65	26
40	461	521	582	643	704	766	827
41	62	22	83	44	05	67	28
42	63	23	84	45	06	68	29
43	64	25	85	46	07	69	30
44	65	26	86	47	08	70	31
45	466	527	587	648	709	771	833
46	67	28	88	49	10	72	34
47	68	29	89	50	12	73	35
48	69	30	90	51	13	74	36
49	70	31	91	52	14	75	37
50	471	532	592	653	715	776	838
51	72	33	93	54	16	77	39
52	73	34	94	55	17	78	40
53	74	35	95	56	18	79	41
54	75	36	96	57	19	80	42
55	476	537	597	658	720	781	843
56	77	38	98	59	21	82	44
57	78	39	600	61	22	83	45
58	79	40	01	62	23	84	46
59	80	41	02	63	24	85	47

Degrees of Latitude.

M.	14	15	16	17	18	19	20
0	848	910	972	1035	1098	1161	1225
1	49	11	73	36	99	62	26
2	50	12	74	37	1100	63	27
3	51	13	75	38	01	64	28
4	52	14	76	39	02	65	29
5	853	915	977	1040	1103	1166	1230
6	54	16	78	41	04	67	31
7	55	17	79	42	05	68	32
8	56	18	81	43	06	69	33
9	57	19	82	44	07	70	34
10	858	920	983	1045	1108	1172	1235
11	59	21	84	46	09	73	36
12	60	22	85	47	10	74	37
13	61	23	86	48	11	75	38
14	62	24	87	49	12	76	40
15	863	925	988	1050	1113	1177	1241
16	64	27	89	52	15	78	42
17	65	28	90	53	16	79	43
18	67	29	91	54	17	80	44
19	68	30	92	55	18	81	45
20	869	931	993	1056	1119	1182	1246
21	70	32	94	57	20	83	47
22	71	33	95	58	21	84	48
23	72	34	96	59	22	85	49
24	73	35	97	60	23	86	50
25	874	936	998	1061	1124	1187	1251
26	75	37	99	62	25	88	52
27	76	38	1000	63	26	90	53
28	77	39	01	64	27	91	54
29	78	40	02	65	28	92	56

Degrees of Latitude.

M.	14	15	16	17	18	19	20
30	879	941	1003	1066	1129	1193	1257
31	80	42	04	67	30	94	58
32	81	43	06	68	31	95	59
33	82	44	07	69	32	96	60
34	83	45	08	70	33	97	61
35	884	946	1009	1071	1135	1198	1262
36	85	47	10	72	36	99	63
37	86	48	11	74	37	1200	64
38	87	49	12	75	38	01	65
39	88	50	13	76	39	02	66
40	889	951	1014	1077	1140	1203	1267
41	90	52	15	78	41	04	68
42	91	53	16	79	42	05	69
43	92	55	17	80	43	07	70
44	93	56	18	81	44	08	72
45	894	957	1019	1082	1145	1209	1273
46	95	58	20	83	46	10	74
47	96	59	21	84	47	11	75
48	98	60	22	85	48	12	76
49	99	61	23	86	49	13	77
50	900	962	1024	1087	1150	1214	1278
51	01	63	25	88	51	15	79
52	02	64	26	89	52	16	80
53	03	65	27	90	54	17	81
54	04	66	29	91	55	18	82
55	905	967	1030	1092	1156	1219	1283
56	06	68	31	93	57	20	84
57	07	69	32	95	58	21	85
58	08	70	33	96	59	22	87
59	09	71	34	97	60	24	88

Degrees of Latitude.

	21	22	23	24	25	26	27
0	1289	1353	1418	1484	1549	1616	1683
1	90	54	19	85	51	17	84
2	91	55	20	86	52	18	85
3	92	56	21	87	53	19	86
4	93	57	22	88	54	20	88
5	1294	1359	1424	1489	1555	1622	1689
6	95	60	25	90	56	23	90
7	96	61	26	91	57	24	91
8	97	62	27	92	58	25	92
9	98	63	28	93	59	26	93
10	99	1364	1429	1495	1561	1627	1694
11	1300	65	30	96	62	28	95
12	02	66	31	97	63	29	96
13	03	67	32	98	64	30	98
14	04	68	33	99	65	32	99
15	1305	1369	1434	1500	1566	1633	1700
16	06	70	36	01	67	34	01
17	07	72	37	02	68	35	02
18	08	73	38	03	69	36	03
19	09	74	39	04	70	37	04
20	1310	1375	1440	1505	1572	1638	1705
21	11	76	41	07	73	39	07
22	12	77	42	08	74	40	08
23	13	78	43	09	75	42	09
24	14	79	44	10	76	43	10
25	1316	1380	1445	1511	1577	1644	1711
26	17	81	47	12	78	45	12
27	18	82	48	13	79	46	13
28	19	83	49	14	80	47	15
29	20	84	50	15	82	48	16

Degrees of Latitude.

M.	21	22	23	24	25	26	27
30	1321	1386	1451	1516	1583	1649	1717
31	22	87	52	18	84	51	18
32	23	88	53	19	85	52	19
33	24	89	54	20	86	53	20
34	25	90	55	21	87	54	21
35	1326	1391	1456	1522	1588	1655	1722
36	27	92	57	23	89	56	24
37	28	93	58	24	90	57	25
38	29	94	60	25	92	58	26
39	30	95	61	26	93	59	27
40	1332	1396	1462	1527	1594	1661	1728
41	33	98	63	29	95	62	29
42	34	99	64	30	96	63	30
43	35	1400	65	31	97	64	31
44	36	01	66	32	98	65	33
45	1337	02	1467	1533	1599	1666	1734
46	38	03	68	34	1600	67	35
47	39	04	69	35	02	68	36
48	40	05	70	36	03	70	37
49	41	06	72	37	04	71	38
50	1342	1407	1473	1538	1605	1672	1739
51	43	08	74	40	06	73	40
52	45	09	75	41	07	74	42
53	46	11	76	42	08	75	43
54	47	12	77	43	09	76	44
55	1348	1413	1478	1544	1610	1677	1745
56	49	14	79	45	12	79	46
57	50	15	80	46	13	80	47
58	51	16	81	47	14	81	48
59	52	17	82	48	15	82	50

Degrees of Latitude.

M.	28	29	30	31	32	33	34
0	1751	1819	1888	1958	2028	2099	2171
1	52	20	89	59	29	2100	72
2	53	21	90	60	30	01	73
3	54	22	91	61	31	03	75
4	55	24	92	62	33	04	76
5	1756	1825	1894	1963	2034	2105	2177
6	57	26	95	65	35	06	78
7	59	27	96	66	36	07	79
8	60	28	97	67	37	09	81
9	61	29	98	68	39	10	82
10	1762	1830	99	1969	2040	2111	2183
11	63	32	1901	70	41	12	84
12	64	33	02	72	42	13	85
13	65	34	03	73	43	14	87
14	66	35	04	74	44	16	88
15	1768	1836	1905	1975	2046	2117	2189
16	69	37	06	76	47	18	90
17	70	38	08	77	48	19	92
18	71	40	09	79	49	21	93
19	72	41	10	80	50	22	94
20	1773	1842	1911	1981	2052	2123	2196
21	74	43	12	82	53	24	97
22	76	44	13	83	54	25	98
23	77	45	14	84	55	27	99
24	78	46	16	86	56	28	2200
25	1779	1848	1917	1987	2057	2129	01
26	80	49	18	88	59	30	02
27	81	50	19	89	60	31	04
28	82	51	20	90	61	33	05
29	84	52	21	91	62	34	06

Degrees of Latitude.

M	28	29	30	31	32	33	34
30	1785	1853	1923	1993	2063	2135	2207
31	86	54	24	94	65	36	09
32	87	56	25	95	66	37	10
33	88	57	26	96	67	39	11
34	89	58	27	97	68	40	12
35	1790	1859	1928	98	2069	2141	2213
36	92	60	30	2000	70	42	15
37	93	61	31	01	72	43	16
38	94	63	32	02	73	45	17
39	95	64	33	03	74	46	18
40	96	1865	1934	2004	2075	2147	2219
41	97	66	35	06	75	48	21
42	98	67	37	07	78	49	22
43	1800	68	38	08	79	51	23
44	01	69	39	09	80	52	24
45	02	1871	1940	2010	2081	2153	2226
46	03	72	41	11	82	54	27
47	04	73	42	13	84	55	28
48	05	74	44	14	85	57	29
49	06	75	45	15	86	58	30
50	1808	1876	1946	2016	2087	2159	2232
51	09	77	47	17	88	60	33
52	10	79	48	18	90	61	35
53	11	80	49	20	91	62	35
54	12	81	51	21	92	64	36
55	1813	1882	1952	2022	2093	2165	2238
56	14	83	53	23	94	66	39
57	16	84	54	24	95	68	40
58	17	86	55	26	97	69	41
59	18	87	56	27	98	70	43

Degrees of Latitude.

M.	35	36	37	38	39	40	41
0	2244	2318	2392	2468	2544	2622	2701
1	45	19	93	69	46	24	02
2	46	20	95	70	47	25	04
3	47	21	96	72	48	26	05
4	49	22	97	73	50	27	06
5	2250	2324	98	2474	2551	2629	2708
6	51	25	2400	75	52	30	09
7	52	26	01	77	54	31	11
8	54	27	02	78	55	33	12
9	55	29	03	79	56	34	13
10	2256	2330	2405	2480	2557	2635	2714
11	57	31	06	82	59	37	16
12	58	32	07	83	60	38	17
13	60	34	08	84	61	39	18
14	61	35	10	86	63	41	20
15	2262	2336	2411	2487	2564	2642	2721
16	63	37	12	88	65	43	22
17	65	39	14	89	66	44	24
18	66	40	15	91	68	46	25
19	67	41	16	92	69	47	26
20	2268	2342	2417	2493	2570	2648	2728
21	70	44	19	95	72	50	29
22	71	45	20	96	73	51	30
23	72	46	21	97	74	52	32
24	73	47	22	98	75	54	33
25	2274	2348	2424	2500	2577	2655	2734
26	76	50	25	01	78	56	36
27	77	51	26	02	79	58	37
28	78	52	27	03	81	59	38
29	79	53	29	05	82	60	40

Degrees of Latitude.

M.	35	36	37	38	39	40	41
30	2281	2355	2430	2506	2583	2662	2741
31	82	56	31	07	85	63	42
32	83	57	32	09	86	64	44
33	84	58	34	10	87	66	45
34	85	60	35	11	88	67	46
35	2287	2361	2436	2512	2590	2668	2748
36	88	62	37	14	91	69	49
37	89	63	39	15	92	71	50
38	90	65	40	16	94	72	52
39	92	66	41	18	95	73	53
40	2293	2367	2442	2519	96	2675	2754
41	94	68	44	20	98	76	56
42	95	70	45	21	99	77	57
43	97	71	46	23	2600	79	58
44	98	72	48	24	01	80	60
45	99	2373	2449	2525	03	2681	2761
46	2300	75	50	27	04	83	62
47	01	76	51	28	05	84	64
48	03	77	53	29	07	85	65
49	04	78	54	30	08	87	67
50	2305	2380	2455	2532	2609	2688	2768
51	06	81	56	33	11	89	69
52	08	82	58	34	12	91	71
53	09	83	59	35	13	92	72
54	10	85	60	37	14	93	73
55	2311	2386	2461	2538	2616	2695	2775
56	13	87	63	39	17	96	76
57	14	88	64	41	18	97	77
58	15	90	65	42	20	99	79
59	16	91	67	43	21	2700	80

Degrees of Latitude.

M.	42	43	44	45	46	47	48
0	2781	2863	2945	3030	3115	3202	3291
1	83	64	47	31	17	04	93
2	84	65	48	32	18	05	94
3	85	67	50	34	19	07	96
4	87	68	51	35	21	08	97
5	2788	2870	2952	3037	3122	3210	99
6	89	71	54	38	24	11	3300
7	91	72	55	39	25	13	02
8	92	74	57	41	27	14	03
9	93	75	58	42	28	16	05
10	2795	2876	2959	3044	3130	3217	3306
11	96	78	61	45	31	18	08
12	97	79	62	47	32	20	09
13	99	80	64	48	34	21	11
14	2800	82	65	49	35	23	12
15	02	2883	2966	3051	3137	3224	3314
16	03	85	68	52	38	26	15
17	04	86	69	54	40	27	17
18	06	87	70	55	41	29	18
19	07	89	72	56	43	30	20
20	2808	2890	2973	3058	3144	3232	3321
21	10	91	75	59	45	33	23
22	11	93	76	61	47	35	24
23	12	94	77	62	48	36	26
24	14	96	79	64	50	38	27
25	2815	97	2980	3065	3151	3239	3329
26	16	98	82	66	53	41	30
27	18	2900	83	68	54	42	32
28	19	01	84	69	56	44	33
29	20	02	85	71	57	45	35

Degrees of Latitude.

M.	42	43	44	45	46	47	48
30	2822	2904	2987	3072	3159	3247	3336
31	23	05	89	74	60	48	38
32	25	07	90	75	61	49	39
33	26	08	91	76	63	51	41
34	27	09	93	78	64	52	42
35	2829	2911	2994	3079	3166	3254	3344
36	30	12	96	81	67	55	45
37	31	14	97	82	69	57	47
38	33	15	99	84	70	58	48
39	34	16	3000	85	72	60	50
40	2835	2918	01	3086	3173	3261	3351
41	37	19	03	88	75	63	53
42	38	20	04	89	76	64	54
43	39	22	06	91	77	66	56
44	41	23	07	92	79	67	57
45	2842	2925	3008	3094	3180	3269	3359
46	44	26	10	95	82	70	60
47	45	27	11	96	83	72	62
48	46	29	13	98	85	73	63
49	48	30	14	99	86	75	65
50	2849	2932	3015	3101	3188	3276	3366
51	50	33	17	02	89	78	68
52	51	34	18	04	91	79	70
53	53	36	20	05	92	81	71
54	54	37	21	07	94	82	73
55	2856	2938	3022	3108	3195	3284	3374
56	57	40	24	09	96	85	76
57	59	41	25	11	98	87	77
58	60	43	27	12	99	88	79
59	61	44	28	14	3200	90	80

Degrees of Latitude.

M.	49	50	51	52	53	54	55
0	3382	3474	3568	3665	3763	3864	3968
1	83	76	70	66	65	66	69
2	85	77	72	68	67	67	71
3	86	79	73	70	68	69	73
4	88	80	75	71	70	71	75
5	3389	3482	3576	3673	3772	3873	3976
6	91	83	78	75	73	75	78
7	92	85	80	76	75	76	80
8	94	87	81	78	77	78	82
9	95	88	83	80	78	80	83
10	3397	3490	3584	3681	3780	3881	3985
11	99	91	86	83	82	83	87
12	3400	93	88	84	83	85	89
13	02	94	89	86	85	87	90
14	03	96	91	88	87	88	92
15	05	98	3592	3689	3788	3890	3994
16	06	99	94	91	90	92	96
17	08	3501	96	93	92	93	97
18	09	02	97	94	93	95	99
19	11	04	99	96	95	97	4001
20	3412	05	3600	97	3797	99	03
21	14	07	02	99	98	3900	04
22	15	08	04	3701	3800	02	06
23	17	10	05	02	02	04	08
24	18	12	07	04	04	05	10
25	3420	3513	3608	06	05	3907	4012
26	22	15	10	07	07	09	13
27	23	16	12	09	09	11	15
28	25	18	13	11	10	12	17
29	26	19	15	12	12	14	19

Degrees of Latitude.

M.	49	50	51	52	53	54	55
30	3428	3521	3616	3714	3814	3916	4020
31	29	23	18	16	15	17	22
32	31	24	20	17	17	19	24
33	32	26	21	19	19	21	26
34	34	27	23	20	20	23	27
35	3435	3529	3624	3722	3822	3924	4029
36	37	30	26	24	24	26	31
37	38	32	28	25	25	28	33
38	40	34	29	27	27	29	34
39	42	35	31	29	29	31	36
40	3443	3537	3632	3730	3830	3933	4038
41	45	38	34	32	32	35	40
42	46	40	36	34	34	36	42
43	48	42	37	35	36	38	43
44	49	43	39	37	37	40	45
45	3451	3545	3641	3739	3839	3942	4047
46	52	46	42	40	41	43	49
47	54	48	44	42	42	45	50
48	55	49	45	44	44	47	52
49	57	51	47	45	46	49	54
50	3459	3553	3649	3747	3847	3950	4056
51	60	54	50	49	49	52	58
52	62	56	52	50	51	54	59
53	63	57	53	52	52	55	61
54	65	59	54	53	54	57	63
55	3466	3561	3657	3755	3856	3959	4065
56	68	62	58	57	58	61	66
57	69	64	60	58	59	62	68
58	71	65	62	60	61	64	70
59	73	67	63	62	63	66	72

Degrees of Latitude.

M.	56	57	58	59	60	61	62
0	4074	4182	4294	4409	4527	4649	4775
1	75	84	96	11	29	51	77
2	77	86	98	13	31	53	79
3	79	88	4300	15	33	55	81
4	81	90	02	17	35	57	83
5	4083	4192	04	4419	4537	4659	4786
6	84	93	05	21	39	61	88
7	86	95	07	23	41	64	90
8	88	97	09	25	43	66	92
9	90	99	11	26	45	68	94
10	4092	4201	4313	4428	4547	4670	96
11	93	03	15	30	49	72	98
12	95	04	17	32	51	74	4801
13	97	06	19	34	53	76	03
14	99	08	21	36	55	78	05
15	4101	4210	4323	4438	4557	4680	4807
16	02	12	24	40	59	82	09
17	04	14	26	42	61	84	11
18	06	16	28	44	63	86	13
19	08	17	30	46	65	88	16
20	4110	4219	4332	4448	4567	4691	4818
21	11	21	34	50	69	93	20
22	13	23	36	52	71	95	22
23	15	25	38	54	73	97	24
24	17	27	40	56	76	99	26
25	4119	4229	4342	4458	4578	4701	4829
26	20	30	43	60	80	03	31
27	22	32	45	62	82	05	33
28	24	34	47	64	84	07	35
29	26	36	49	66	86	09	37

Degrees of Latitude.

M.	56	57	58	59	60	61	62
30	4128	4238	4351	4468	4588	4711	4839
31	29	40	53	70	90	14	41
32	31	42	55	72	92	16	44
33	33	43	57	74	94	18	46
34	35	45	59	76	96	20	48
35	4137	4247	4361	4478	98	4722	4850
36	39	49	63	79	4600	24	52
37	40	51	65	81	02	26	55
38	42	53	66	83	04	28	57
39	44	55	68	85	06	30	59
40	4146	4257	4370	4487	4608	4733	4861
41	48	58	72	89	10	35	63
42	49	60	74	91	12	37	65
43	50	62	76	93	14	39	68
44	53	64	78	95	16	41	70
45	4155	4266	4380	97	4618	4743	4872
46	57	68	82	99	20	45	74
47	59	70	84	4501	22	47	76
48	60	72	86	03	24	49	79
49	62	73	88	05	26	52	81
50	4164	4275	4390	07	4629	4754	4883
51	66	77	92	09	31	56	85
52	68	79	93	11	33	57	87
53	70	81	95	13	35	60	89
54	71	83	97	15	37	62	91
55	4173	4285	99	4517	4639	4764	4894
56	75	87	4401	19	41	60	96
57	77	88	03	21	43	68	98
58	79	90	05	23	45	71	4900
59	81	92	07	25	47	73	03

Degrees of Latitude.

M.	63	64	65	66	67	68	69
0	4905	5039	5179	5324	5474	5631	5795
1	07	42	81	26	77	34	98
2	09	44	84	29	79	37	5800
3	11	46	86	31	82	39	03
4	14	49	88	33	84	42	06
5	4916	5051	5191	5336	5487	5644	5809
6	18	53	93	38	89	47	12
7	20	55	95	41	92	50	14
8	23	58	98	43	95	52	17
9	25	60	5200	46	97	55	20
10	4927	5062	03	5348	5500	5658	5823
11	29	65	05	51	02	60	26
12	31	67	07	53	05	63	28
13	34	69	10	56	08	66	31
14	36	71	12	58	10	69	34
15	4938	5074	5214	5361	5513	5671	5837
16	40	76	17	63	15	74	40
17	42	78	19	66	18	77	43
18	45	81	22	68	20	79	45
19	47	83	24	71	23	82	48
20	4949	5085	5226	5373	5526	5685	5851
21	51	88	29	76	28	87	54
22	54	90	31	78	31	90	57
23	56	92	34	81	33	93	60
24	58	95	36	83	36	96	62
25	4960	97	5238	5386	5539	5698	5865
26	63	99	41	88	41	5701	68
27	65	5101	43	91	44	04	71
28	67	04	46	93	46	06	74
29	69	06	48	96	49	09	77

Degrees of Latitude.

M.	63	64	65	66	67	68	69
30	4972	5108	5250	5398	5552	5712	5879
31	74	11	53	5401	54	15	82
32	76	13	55	03	57	17	85
33	78	15	58	06	60	20	88
34	81	18	60	08	62	23	91
35	4983	5120	5263	5411	5565	5726	94
36	85	22	65	13	67	28	97
37	87	25	67	16	70	31	5900
38	90	27	70	18	73	34	02
39	92	29	72	21	75	37	05
40	4994	5132	5275	5423	5578	5739	5908
41	96	34	77	26	81	42	11
42	99	36	80	28	83	45	14
43	5001	39	82	31	86	48	17
44	03	41	84	33	88	50	20
45	05	5143	5287	5436	5591	5753	5923
46	08	46	89	38	94	56	25
47	10	48	92	41	96	59	28
48	12	51	94	43	99	61	31
49	14	53	97	46	5602	64	34
50	5017	5155	99	5449	04	5767	5937
51	19	58	5301	51	07	70	40
52	21	60	04	54	10	72	43
53	23	62	06	56	12	75	46
54	26	65	09	59	15	78	49
55	5028	5167	5311	5461	5618	5781	5952
56	30	69	14	64	20	84	55
57	33	72	16	66	23	86	57
58	35	74	19	69	26	89	60
59	37	76	21	72	28	92	63

Degrees of Latitude.

M.	70	71	72	73	74	75	67
0	5966	6146	6335	6534	6746	6971	7211
1	69	49	38	38	50	75	15
2	72	52	42	42	54	79	19
3	75	55	45	45	57	83	23
4	78	58	48	49	61	87	27
5	5981	6161	6351	6552	6765	6990	7232
6	84	65	55	57	68	94	36
7	87	68	58	59	72	98	40
8	91	71	61	62	75	7002	44
9	93	74	64	66	79	06	48
10	96	6178	6367	6569	6782	10	7253
11	98	80	71	73	86	14	57
12	6001	83	74	76	90	18	61
13	04	86	78	80	94	22	65
14	07	89	81	83	98	26	69
15	10	6192	6384	6587	6801	7030	7274
16	13	96	87	90	05	33	78
17	16	99	91	94	09	37	82
18	19	6202	94	97	12	41	86
19	22	05	97	6601	16	45	90
20	6025	08	6304	04	6820	7049	7295
21	28	11	05	08	23	53	99
22	31	14	07	11	27	57	7303
23	34	17	10	14	31	61	07
24	35	21	14	18	35	65	12
25	6040	6224	6417	6621	6838	7069	7316
26	43	27	20	25	42	73	20
27	46	30	24	29	46	77	24
28	49	33	27	32	49	81	29
29	52	36	30	36	53	85	33

Degrees of Latitude.

M.	70	71	72	73	74	75	76
30	6055	6239	6434	6639	6857	7089	7337
31	58	43	37	43	61	93	42
32	61	46	40	46	64	97	46
33	64	49	44	50	68	7101	50
34	67	52	47	53	72	05	54
35	6070	6255	6450	6657	6876	09	7359
36	73	58	54	60	79	13	63
37	76	62	57	64	83	17	67
38	79	65	60	67	87	21	72
39	82	68	64	71	91	25	76
40	6085	6271	6467	6674	6895	7129	7380
41	88	74	70	78	98	33	85
42	91	77	74	82	6902	37	89
43	94	81	77	85	06	41	93
44	97	84	81	89	10	45	98
45	6100	6287	6484	6692	6914	7149	7402
46	03	90	87	96	17	53	06
47	06	93	91	99	21	58	11
48	09	97	94	6703	25	62	15
49	12	6300	97	07	29	66	20
50	6115	03	6501	6710	6933	7170	742[illegible]
51	18	06	04	14	36	74	28
52	22	09	08	17	40	78	3[illegible]
53	25	13	11	21	44	82	3[illegible]
54	28	16	14	25	48	86	4[illegible]
55	6131	6319	6518	6728	6952	7190	744[illegible]
56	34	22	21	32	56	94	5[illegible]
57	37	26	25	35	59	99	5[illegible]
58	40	29	28	39	63	7203	5[illegible]
59	43	32	31	43	67	07	6[illegible]

Degrees of Latitude.

M.	77	78	79	80	81	82	83
0	7468	7746	8047	8377	8741	9148	9609
1	73	51	52	83	47	55	17
2	77	55	58	88	54	62	25
3	82	60	63	94	60	69	33
4	86	65	68	8400	67	77	42
5	7491	7770	8073	06	8773	9184	9650
6	95	75	79	12	80	91	58
7	99	80	84	17	86	99	67
8	7504	84	89	23	93	9206	75
9	08	89	95	29	99	13	83
10	13	94	8100	8435	8806	9220	92
11	17	99	05	41	12	28	9700
12	22	7804	11	47	19	35	09
13	27	09	16	53	25	43	17
14	31	14	21	58	32	51	26
15	7536	19	8127	8464	8838	9257	9734
16	40	24	32	70	45	65	43
17	45	29	37	76	52	72	51
18	49	33	43	82	58	80	60
19	54	38	48	88	65	87	68
20	7558	7843	8154	94	8871	95	9777
21	63	48	59	8500	78	9302	86
22	67	53	64	06	85	10	94
23	72	58	70	12	91	17	9803
24	77	63	75	18	98	25	12
25	7581	7868	8181	8524	8905	9333	20
26	86	73	86	30	11	40	29
27	90	78	92	36	18	48	38
28	95	83	97	42	25	55	47
29	7600	88	8203	48	32	63	56

Degrees of Latitude.

M.	77	78	79	80	81	82	83
30	7604	7893	8208	8554	8938	9371	9864
31	09	98	14	60	45	78	73
32	13	7903	19	66	52	86	82
33	18	08	25	72	59	94	91
34	23	13	30	79	66	9401	9900
35	7627	7918	8236	8585	8972	09	09
36	32	23	41	91	79	17	18
37	37	28	47	97	86	25	27
38	41	34	52	8603	93	32	36
39	46	39	58	09	9000	40	45
40	7651	7944	8263	8615	07	9448	9954
41	55	49	69	22	14	56	63
42	60	54	75	28	21	64	72
43	65	59	80	34	28	72	81
44	70	64	86	40	35	80	90
45	7674	7969	8291	8646	9042	88	10000
46	79	74	97	53	49	96	09
47	84	80	8303	59	56	9503	18
48	88	85	08	65	63	11	27
49	93	90	14	71	70	19	37
50	98	95	8320	8678	9077	9527	10046
51	7703	8000	25	84	84	36	55
52	07	05	31	90	91	44	65
53	12	11	37	97	98	52	74
54	17	16	42	8703	9105	60	83
55	7722	8021	8348	8709	12	9568	10093
56	27	26	54	16	19	74	10102
57	31	31	60	22	26	83	12
58	36	37	65	28	33	92	21
59	41	42	71	35	41	9600	31

Degrees of Latitude.

M.	84	85	86	87	88	89
00	10140	10769	11538	12520	13920	16317
1	50	81	53	40	48	75
2	60	92	67	59	78	16435
3	69	10804	82	78	14007	9[illegible]
4	79	15	96	98	37	1655[illegible]
5	89	27	11611	12618	66	1661[illegible]
6	98	39	26	37	97	8[illegible]
7	10208	51	41	57	14127	16747
8	18	62	55	77	58	16813
9	28	74	70	97	89	81
10	10238	86	85	12718	14220	1695[illegible]
11	48	99	11700	38	52	1702[illegible]
12	57	10910	15	58	83	91
13	67	22	30	79	14316	1716[illegible]
14	77	34	46	12800	48	1723[illegible]
15	87	46	61	21	81	1731[illegible]
16	97	58	78	42	14414	9[illegible]
17	10307	70	92	63	47	1747[illegible]
18	17	82	11807	84	81	1755[illegible]
19	27	95	23	12905	14515	1763[illegible]
20	10338	11007	38	27	49	1772[illegible]
21	48	19	54	48	84	1781[illegible]
22	58	32	70	70	14619	1790[illegible]
23	68	44	86	92	55	9[illegible]
24	78	57	11902	13014	90	1809[illegible]
25	89	69	18	36	14727	1819[illegible]
26	99	82	34	59	63	1829[illegible]
27	10409	94	50	81	14800	1839[illegible]
28	20	11107	66	1310[illegible]	37	1850[illegible]
29	30	20	82	26	75	1861[illegible]

Degrees of Latitude.

M.	84	85	86	87	88	89
30	10440	11138	11999	13150	14914	18729
31	51	45	12015	73	52	18848
32	62	58	32	96	91	18970
33	72	71	48	13219	15031	19098
34	83	84	65	43	71	19230
35	93	97	82	66	15111	19368
36	10504	11210	99	91	52	19511
37	14	23	12116	13315	94	19660
38	25	36	33	39	15236	19816
39	36	49	50	63	78	19980
40	10547	62	67	88	15321	20152
41	57	76	84	13412	64	20333
42	68	89	12202	37	15408	20524
43	79	11303	19	62	53	20726
44	90	16	37	88	98	20941
45	10601	29	54	13513	15544	21170
46	12	43	72	39	91	21460
47	23	57	90	65	15638	21680
48	34	70	12308	91	86	21967
49	45	84	26	13617	15734	22279
50	10656	98	44	43	83	22623
51	67	11412	62	70	15833	23005
52	78	25	81	97	84	23435
53	90	39	99	13725	15935	23926
54	10701	53	12408	51	87	24499
55	12	67	26	79	16040	25186
56	23	81	45	13807	93	26046
57	35	96	64	34	16148	27192
58	46	11510	83	63	16203	28911
59	58	24	12502	91	60	32348

The Construction of the True Sea-Chart, by the Table of the Meridional Parts.

FIG. 60.

LEt it be required to make a Chart from the Latitude of 48° 00′ to the Latitude of 54° containing eight degrees of Longitude.

Draw the line AB, which divide into eight equal parts, so shall each part represent a Degree of Longitude: Upon A, draw AC perpendicular to AB; and from B, draw BD parallel to AC: also from each of the eight equal divisions in the line AB draw Parallel lines, as in the Figure; so shall these lines represent Meridians.

To graduate the Meridian AC or BD, find in the foregoing Table, the Meridional parts for 48° of Latitude, *viz.* 3291. Also find the responding parts of the Latitude of 49° 00′, *viz.* 3382. subtract the lesser of those two numbers from the greater, and the remainer will be 91.

This done, you must divide each of the eight equal parts in the line AB into 10 other equal parts, so shall each of these small Divisions contain six minutes. Lastly, from this Scale AB take 91 parts and set the same from 48 to 49 upon the Meridian line AC, and from 49 draw the Parallel from that Latitude. Again, from the Meridional parts answering to 50 deg. (the next degree of Latitude) *viz.* 3474, take the Meridional parts for 49° of Latitude, *viz.* 3382.

the

the remainer is 92, which taken from the line AB, muſt be applyed from 49 to 50 degrees, then draw the parallel of 50 degrees as in the Figure, and ſo proceed till you come to 54 degrees of Latitude.

Laſtly, That the diſtance of places may be more readily found by this Chart, you muſt draw the line EF, which is divided into 5 degrees 24 minutes: each degree in this line being equal to two Degrees in the Line AB, and divided into ten equal parts, as were the other. This line ſo graduated is called the Auxiliary line, whoſe uſe ſhall be declared in its due place.

Having thus far explained the Conſtruction of ſuch Geographical Charts, (both General and Particular, Circular, and Rectilinear) as are moſt neceſſary for underſtanding the true Idea of Navigation, I proceed to their uſe; omitting the Conſtruction of thoſe, whoſe Lineaments depend upon Segments of Ellipſes, and Hyperbola's, becauſe it is impoſſible to underſtand the nature of theſe lines without ſome previous Account of Gonic Sections.

CHAP. IX.

Of the Mariner's Compaſs, and of the Nature of Rumb-lines. Fig. 32. Plate 2*d.*

WHen mankind firſt became ſenſible of the poſſibility of travelling by Sea, as well as upon the *Terra Firma*, they began to conſider the ſituation of places. To which end they divided the Horizon into four equal parts, called Eaſt, South, Weſt and North, being directed to theſe 4 Coaſts by the motion of the Sun, *viz.* at his riſing, they found the Eaſt point; at his Southing the South and North points, and at his Setting, the Weſt point.

But this advantage was of no uſe to them in the night time, which obliged them more narrowly to conſider the motion of the fixed Stars, *viz.* the Pleiades, and the laſt in the Tayl of the little Bear: That the Pleiades was uſed by the Ancients for this purpoſe, ſeems to be implyed from the Etymologie of the word; for in the Greek, πλέω (from whence ſome think the word Pleiades took it's name) ſignifies to Sayle, and becauſe of it's poſition, which is not far from the Equator, whereby they could in the

the Night discover the East by it's rising; the South and North, by it's Culmination; and the West points of the Horizon by it's setting.

The last Star in the little Bear's tayle has been for many Ages so near the North pole of the World, that the Circle it describes about it is almost insensible; and therefore as Seamen used it before the discovery of the Magnet, the difference in being directed by this Star, or by the Pole it self was inconsiderable.

This was the practice of Seamen in the Infancy of Navigation, and when intervening Clouds did not deprive them of these helps, were the best guides they had to direct them in their Course: but in thick and cloudy weather, they were at a loss, not knowing which way to steer, till the use of the Magnet came to be known: and then they took leave of their old Friends, the Stars, having no further occasion for their help.

Also those who inhabited the Southern Temperate Zone, or any where between the Equator and the South Pole, were totally deprived of the Benefit of being directed by the Pole Star, because there is no remarkable Star posited so near to the South Pole, as that of the little Bear, is to the North.

But upon the Invention of the Compass, they found a certain Directory both by day and night: this Compass they divided into 32 equal parts, whose Names in these five several Languages are as follow.

Englifh	Latin	Greek	Italian	Spanifh
North	*Septentrio*	Απαρκτίας	*Tramantana*	*Norte*
N by E	*Hypaquilo*	Ὑπερβορέας	*4 di Tramontana Græco*	*Norte 4 a Nordeft*
N N E	*Aquilo*	Βορέας	*Tramontana Græco*	*Nord' Nord' efte*
N E by N	*Mefaquilo*	Μεσοβορέας	*4 di Tramontano Græco*	*Nord' efte 4 a Norte*
N E	*Borrapeliotes*	Βορραπηλιώτης	*Græco*	*Nord' efte*
N E by E	*Hypocæcias*	Ὑποκαικίας	*4 di Græco Levante*	*Nord 4 al Efte*
E N E	*Cæfias*	Καικίας	*Levante Græco*	*Les Nord d' Efte*
E by N	*Mefocæcias*	Μεσοκαικίας	*4 di Levante Græco*	*Les 4 a Nordefte*
Eaft	*Subfolanus*	Απηλιώτης	*Levante*	*L'efte*
E by S	*Ypeurus*	Ὑπεὖρος	*4 di Levante Sirocco*	*L'efte 4 a Suefte*
E S E	*Eurus*	Εὖρος	*Levante Sirocco*	*L'e Suefte*
S E by E	*Mefeurus*	Μεσεῦρος	*4 di Levante Sirocco*	*Suefte 4 al' Efte*
S E	*Notapeliotes*	Νοταπηλιώτης	*Sirocco*	*Suefte*
S E by S	*Hypophœnix*	Ὑποφοινίκιας	*4 di Sirocco Oftro*	*Suefte 4 al' Sur*
S S E	*Phœnix*	Φοινίκιας	*Oftro Sirocco*	*Sur Suefte*
S by E	*Mefophœnix*	Μεσοφοινίκιας	*4 di Oftro Sirocco*	*Sur 4 a Suefte*

Englifh

English	Latin	Greek	Italian	Spanish
South	*Notus*	Νότος	*Ostro*	*Sur*
S by W	*Mesolibanotus*	Μεσολιβάνοτος	*4 di Ostro Garbino*	*Sur 4 al Sudeste*
S S W	*Libanotus*	Λιβάνοτος	*Ostro Garbino*	*Sud Sudueste*
S W by S	*Hypolibanotus*	Ὑπολιβάνοτος	*4 di Garbino Ostro*	*Sud Vest 4 al' Sud*
S W	*Notalybicus*	Νοτολίψ	*Garbino o Libeccio*	*Sud Vest*
SWby W	*Mesafricus*	Μεσολίψ	*4 di Garbino Ponente*	*Sud Vest 4 al Oste*
W S W	*Africus*	Λὶψ	*Ponente Garbino*	*Ooste Sud Oste*
W by S	*Hypafricus*	Ὑπολίψ	*4 di Ponente Garbino*	*Oest 4 al Suduest*
West	*Zephyrus*	Ζέφυρος	*Ponente*	*Oest*
W by N	*Mesocorus*	Μεσαργέστης	*4 di Ponente Maestro*	*Oest 4 al Nord Oest*
W N W	*Corus*	Ἀργέστης καῦρος	*Ponente Maestro*	*Oest Nord Oeste*
N W by W	*Hypocorus*	Ὑπαργέστης	*4 di Maestro Ponente*	*Nord Oest 4 al Nort*
N W	*Borrolybicus*	Βορρολίψ	*Maestro*	*Nord Oeste*
NWbyN	*Hypocircius*	Ὑποκίρκιος	*4 di Maestro Tramont*	*Nord Oeste 4 a Nor*
N N W	*Circius*	Κίρκιος	*Tramentana Maestro*	*Nor Nor Oeste*
N by W	*Mesocircius*	Μεσοκίρκιος	*4 di Tramon. Maestro*	*Nor 4 a Norocste*

By

By the Sea Compaſs we learn to find the true Courſe between any two Places; a ſecret not known till the diſcovery of this uſeful Inſtrument: for how could the Seamen of old, fluctuating upon the ſurface of the Sea, where they could ſee nothing, *niſi Pontus & Æther*; direct a Ship between any two places, not knowing the Rhumb or Courſe from the one to the other? The want of which knowledge did much retard the improvement of Navigation in thoſe times; And this was the reaſon why the new world of *America* lay ſo long undiſcovered.

The Sea Compaſs (by which we find out the Courſe from one place to another) is nothing elſe than a Box having a Braſs Pin in the middle, upon which a round piece of ſtiff Paper (furniſhed with a hollow Center, called the Cap, and a piece of Steel or Iron Wyer) always moves. This Wyer being commouly bent in form of a Rhombus, one of its angles lying under the North point or *Flower de luce*, the other oppoſite angle lying under the South Point thereof. This Inſtrument being thus far prepared, they take the Chard or ſtiff Paper, the Wyer being firſt faſtened to it, and rub the acute angle of the Rhombus which lies under the No. Point, upon the South Pole of the Magnet, and the oppoſite acute angle of the Rombus which lies under the South Point of the Chard, they rub upon the North Pole of the ſame Magnet, and then the Chard being placed with its Cap upon the Pin, does (by an unaccountable property of the Stone) apply it ſelf to a true Meridian, or near to that Poſition. The virtue of this Stone or

Magnet

Magnet is ſuch, that if the Poles thereof be firſt found, and the Magnet it ſelf be appended to a ſtring, ſo, that it may move freely (without any impediment) it will never ceaſe to move, till its Poles ſtand exactly North or South. And this is the Conſtruction of that Inſtrument called the Sea-Compaſs, by whoſe help we can direct a Ship through the untrac'd ſurface of the Sea, between any two aſſigned Places.

The Compaſs thus prepared and touched, does in ſome places apply it ſelf to a true Meridian, in other places, it does not ſhew the true North and South Points of the Horizon, but deviates from them, and this deviation is called the declination thereof, or variation.

Thus at the Azores, the Compaſs had no variation, but in ſeveral places which lie under that Meridian, there has been found a variation. In places diſtant from the Azores Eaſtward, almoſt to the Cape of Good-Hope, the Compaſs declines from the North Eaſtward, and the Declination thereof is near equal, in all places between the Azores and Cape *Agullas*; it continues to decline more and more till you come about 70 degrees further than the Meridian of *Triſtan*, where the Declination is about 13°. from thence it decreaſeth till you come to the Meridian of *Agullas*.

Nor has one and the ſame City the ſame Declination at all times, for here at *London* 1580 the Declination was 11°. 15'. and in the Year 1622 at the ſame place it was found to be 6°. 13'. in the year 1634, it was 4°. 06'. The Reaſon of which Phænomenon may be this. The Globe of Earth

Earth and Sea is of an unequal Temper, consist-ing more of Water than of Earth in some places, and of Earth more or less Magnetical in others therefore it must needs be here and there led a-side towards the East and West.

And because the Compass is liable to a variati-on from the true North and South Points of the Horizon; and having a variation, is thereupon unfit to direct a Ship in her true Course, at Sea we will here shew the way how to find the quanti-ty of the variation of the Compass.

To find the variation of the Compass.

THe variation of the Compass is usually found by the Sun's Amplitude at his Rising or Setting, but this way is attended with two incon-veniences.

1. The Latitude of the Ship must be exactly known at the time of Sun Rising or Setting: which is somewhat too difficult for our ordinary Sea-men, unless they be well grounded in the soluti-on of Spherical Triangles.

2. That the refraction of the Sun makes him appear to be in the Horizon, when he is really about 34 minutes below it. Therefore I shall substitute another way to perform the same, which is less difficult, and more certain: in order to which observe these follow-ing Rules.

1. Observ

1. Obſerve the Sun's Altitude, and point of the Compaſs he is upon at that moment of time, *viz.* about 7, 8, or 9 a Clock in the morning.

2. Obſerve the point of the Compaſs the Sun is upon, when he has the ſame Altitude in the Afternoon, as he had in the morning, which will happen about 3, 4 or 5 a Clock in the Afternoon, and from theſe two obſervations may the variation be found.

For if theſe points of the Compaſs be equally diſtant from the North or South points of the Compaſs, then there is no variation.

But if the point in the Forenoon, be further diſtant from the Meridian line of the Compaſs, than the point in the Afternoon, then is the variation weſterly.

Laſtly, If the point in the Forenoon be leſs diſtant from the Meridian line of the Compaſs, than the point in the Afternoon, then is the variation Eaſtward.

The quantity of the variation is thus found, take the intercepted Arches between the North point of the Compaſs, and theſe two points, the one in the Forenoon, and the other in the Afternoon found by Obſervation, the leſſer of theſe two Arches being ſubtracted from the greater, half of the remainer is the variation required.

To

To find what angle each point of the Compaſs makes with the Meridian.

DIvide 360°.the number of Degrees in the circumference of any Circle by 32 the number of Points in the Compaſs,the Quotient is 11°. $\frac{8}{32}$ or $\frac{1}{4}$ which is 11°. 15′. and from hence was this following Table computed, which ſhews how many Deg. and Minutes anſwer to 1. or $\frac{1}{2}$ or $\frac{1}{4}$ point of the Compaſs.

North

	North	South	D.	M.	South	North	
			2.	48			
			5.	37			
			8.	25			
1	NBE	SBE	11.	15	BW	NBW	1
			14.	04			
			16.	53			
			19.	41			
2	NNE	SSE	22.	30	SSW	NNW	2
			25.	19			
			28.	08			
			30.	56			
3	NEBN	SEBS	33.	45	SWBS	NWBN	3
			36.	34			
			39.	23			
			42.	11			
4	NE	SSE	45.	00	SW	NW	4
			47.	49			
			50.	37			
			53.	26			
5	NEBE	SEBE	56.	15	SWBW	NWBW	5
			59.	04			
			61.	52			
			64.	41			
6	ENE	ESE	67.	30	WSW	WNW	6
			70.	19			
			73.	07			
			75.	56			
7	EBN	EBS	78.	45	WBS	WBN	7
			81.	34			
			84.	22			
			87.	11			
8	East	West	90.	00	West	West	8

Of the Nature of Rhomb-Lines.

When the Ship Sails upon the Meridian, or upon any Parallel, it is nothing difficult to determine her way. But when the Ship Sails upon any other point of the Compaſs, this difficulty is greater than every man imagins; becauſe ſhe alters both her Latitude and Longitude. This Difficulty is ſo much the greater, by how much the Voyage is more diſtant from the Æquinoctiall towards either Pole: and by how much the Rhumb or point of the Compaſs ſhe Sails upon, is more remote from the Meridian.

For near the Equinoctial, where the Meridians are almoſt parallel; and in thoſe Rhumbs which are near the Meridian, where the Longitude is but little alter'd, the Errour is inſenſible.

In Sailing upon any of theſe Oblique Rhumbs the Ship is ſo directed by the Compaſs, and guided by the Helme, that the line ſhe Sails upon does every where keep the ſame Angle with the Meridian according to the diſtance of that Rhumb from the North or South line. And becauſe the Compaſs is as it were a moveable Horizon: and the lines of direction thereupon are the interſections of Azimuths with the ſame Horizontal plain, dividing it into ſo many parts which are called Rhumbs: it comes to paſs, that in ſuch Oblique Sailing towards the elevated Pole, the place whereunto the the Compaſs leads is evermore between the Parallel of that Place where you are, and the Pole. Wherefore the line of the Ship's Oblique Courſe is an Helix or Spiral

line, approaching nearer and nearer to the Pole, but never falling into it. Thus in Fig. 59. let P represent but the Pole of the World, and all the Concentric Circles to be parallels of Latitude described at equal diſtance one from the other, and let the ſtreight lines PAC. PEB. PID. POF. PVG cutting theſe Parallels in the points C. B. D. F. G. H be Meridians: and let all the Segments CA. BE. DI. OF. VG be equal in length, tho' the Angles CPA. BPD, &c. be unequal. Then let us ſuppoſe the Ship to Sail directly NE. ſhe ſhall thereby deſcribe the arching line CBDFGH. this line does continually approach nearer and nearer to the Pole, but can never fall into the Pole, becauſe it ſtill keepeth the ſame diſtance upon the Compaſs between the Meridian and the Parallel in which it is, and maketh with the Meridian, an angle of 45°.

Theſe Spirals (as the learned Dr. *Oughtred* tells you) ought to conſiſt of the moſt minute yea indiviſible parts, for if they be any whit great, the account of the Ship's motion will be confounded; and carry'd down from the true place whither the Ship is gone, towards the Equinoctial: neither can you return by the Rhumb you came. For imagine in Fig. 59. two Meridians PAC. PBK. and that AB and CK are like Segments of two Parallels; ſo ABCK ſhall be a kind of a right-angled Spherical Quadrangle, in which let there be drawn the Diagonal CB. upon which the Ship is ſuppoſed to have moved from C to B. it may eaſily be demonſtrated that the angle PBL is greater than the angle ACB. this ſheweth that you are fallen from your Rhumb into ano-

ther point, and had need to bear up the Ship again into the Rhumb BD, making with the Meridian an angle PBD equal to that other ACB. Again, the Diagonal arch CB cutteth the Quadrangle into two Triangles unequal one to the other: for tho' in both the ſides AC. BK. be equal, and the ſide CB be common to them both, yet the Baſes A B and CK, and likewiſe their angles are unequal, yea tho' the diſtance of the Parallels be but one Scruple of a Degree. And the leſs you take the diſtance of theſe Parallels that inequality will alſo be the leſs. So that if by any artifice it may be brought about that the Arch AC be not one Minute of a degree, which upon the Snrface of the Earth is 1. 159. Engliſh mile. but the 100000*th*. part thereof which is leſs than one Inch, there may be Tables calculated to the Radius of 10000000 which ſhall reduce theſe ſmall Spherical Triangles into right angled Spherical Triangles, whereby the Spiral line of the Ship's Courſe may be recall'd to preciſe exactneſs.

Thus having given you a tranſient account of the Compaſs, it's variation, and the nature of Oblique Rhumb-lines, I proceed to ſeveral uſeful Geographical Propoſitions before I enter upon the uſe of the Charts, or the Art of Navigation.

CHAP.

CHAP. X.

To find the distance of Places when they lye under the same Meridian, or in the same Parallel.

PROB. 1. Fig. 58.

TO find the Semidiameter of any Parallel, either in Sexagenary or English Miles.

Seeing that every degree is usually divided into 60 equal parts, commonly called Miles, these Miles we may call Sexagenary Miles; each of which exceeds an English Mile, as I noted before, therefore the Semidiameter of the Equinoctial being 60° multiply that by 60 the Sexagenary Miles in a degree, the product 3600 shall be the Semidiameter of the Equator in Sexagenary Miles.

But if you desire the Semidiameter of the Equator in English miles, then because 69.548 English make a degree, therefore multiply 69.548 by 60, the Product 4172.88 shews the Eeglish miles contained in the Semidiameter of the Equator, which being known if it be required to

find the Semidiametar of any other Parallel, as of 30 degrees in Sexagenary miles, say,

As Radius ÆC sine of 90°. 00' — 10000000
Is to Semidiameter ÆC 3600 — 3556303
So is the Co-Sine of 30°. 00' — 9937530

to the numb. of Sexa. miles in that Pa. 3128. 3493833

Again to find the same in English miles,

As Radius ÆC. Sine of 90°. 00' — 100000000
Is to Semi. of the Equa. ÆC 4172. 88 — 3620427
So is the Co-Sine of 30°. 00' *viz.* AD — 9937530
to the num. of Eng. miles in that Pa. 3613. 3557957

PROB. 2. Fig. 58.

To find how many Miles (both Sexagenary and English) make a degree of Longitude in any Parallel.

In the Latitude of 30°. 00'. I demand how many Sexagenary, and also English Miles, make a degree of Longitude, then because 60 Sexagenary miles make a degree of Longitude at the Equator, and also 69. 548 English miles make a degree of Longitude at the same, therefore say for Sexagenary miles.

As the Radius Sine of 90°. 00 ÆC — 10000000
Is to one deg. at the Eq. *viz.* ÆC. 60 miles 1778151
So is the Co-Sine of the gi. La. AD. 30. 00 — 9937530

to the num. of miles in a deg. of that Parallel, *viz.* AD 51. 96 — } 1715681

To find the same in English miles.

As

As Radius Sine of 90°. 00' *viz.* ÆC. 10000000
Is to 69.548 miles in the Equator EC—1841609
So is Co-Sine of the gi.La. AD 30°. 00'-9937530

to the num.of En. miles required 60.22--1779139

P R O B. 3. Fig. 58.

To find the distance of Places posited under the same Meridian.

Two Places cannot be further distant than 180°. or 10800 Sexagenary miles—or lastly 12518. 64 English miles.

CASE 1.

1. *If the two Places be posited in the same Quadrant of the same Meridian.*

Subtract the Latitude of the lesser, from the Latitude of the greater, the remainer shall be the difference of Latitude in Degrees and minutes, which reduced into Miles gives the distance required—Exam.

Let there be two Places, the one at H, the other at I both in the same Quadrant of the same Meridian, that at H in the Latitude of 40°. 00′ N°. and the other at I in the Latitude of 50°. 00′. both under the same Meridian ANP. RSP. from

	ÆI 50°. 00′.	10	
Subtract	ÆH 40. 00	60	
Remains	HI—10. 00	600	Sexagenary miles.

69. 548
10

695.480 Eng. miles.

CASE 2.

If the two Places propounded be indifferent Quadrants of the same Meridian, viz. *the one in North the other in South Latitude, to find their distance asunder.*

Let the one lye in 40°. 00′ North Latitude, the other in 30°. South Latitude add these two numbers together, and their Sum shall be the difference of Latitude or nearest distance in degrees and minutes, which reduce as afore.

40
30

diff. Lati. D. M. 70
60

distance in Sexagen. 4200 miles.

CASE

CASE 3.

If the two places lye under the same Meridian, the first on this side the Pole; the second on the other side thereof, the sum of the Complement of these two Latitudes shall be their difference of Latitude, or nearest distance in degree and minute,

EXAMPLE.

Let one Place lye at K on this side the Pole in the North Latitude of 59°. 40'. and let the other Place be I on the other side of the Pole, *viz.* in the North Latitude of 82°. 00' I demand their distance they being both under one Meridian.

The Complement of QL 82°. 00' is NPL 8°. 00', the Complement of ÆK 59°. 40' is KNP 30°. 20'. these two Complements added together make 38°. 20'. for KL the nearest distance in degrees and minutes.

38°. 20
60

Distance in Sexagenary miles 2300

CASE 4.

If two places both under one Meridian be posited in different Quadrants of the same Meridian, these Quadrants not being contiguous, subtract the lesser Latitude from the greater, and that

that remainer from a Semicircle, ſo ſhall you have their neareſt diſtance required.

EXAMPLE.

Let one place be K in the North Latitude of 59°. 40′ the other be M in the South Latitude of 30°. 00′. to find their neareſt diſtance in Sexagenary miles.

59°. 40′ diſtance in D. M. 150°. 20′
30. 00 60

29. 40 diſtance in Sexag. miles. 9020

180. 00

150. 20

PROB. 4. Fig. 58.

If two Places lye under the Equator, and the Longitudes of theſe two Places be known, the difference of Longitude between them is their neareſt diſtance in degrees and minutes; but if this difference of Longitude exceed 180°. 00′. Subtract it from 360°. 00′ and the remainer ſhall be the diſtance required in degrees and minutes.

PROB.

PROB. 5. Fig. 58.

Having the difference of Longitude between two Places lying both in one Parallel, to find their nearest distance in Sexagenary miles.

By Prob. 2. of this Chap. find the number of miles in the Equator which make a degree of Longitude in that Parallel; then multiply the difference of Longitude between these two Places by the Equatorial miles in that Parallel, the product shall be the nearest distance required.

EXAMPLE.

Let the two places be both in the Parallel of 50. and let their diff. Longitude be 12°. then by Problem 2. of this Chap. it appears that 38. 57 Equatorical or Sexagenary miles make a degree of Longitude in that Latitude, therefore

$$
\begin{array}{r}
38.\ 57 \\
12 \\
\hline
7714 \\
3857 \\
\hline
\end{array}
$$

Distance required 462. 84 in Sexagenary miles.

The distance of any two places not posited as in these Examples, shall be discoursed of at large in the ensuing Chapter

CHAP.

CHAP. XI.

The use of the Plain Sea Chart.

PROP. I. Fig. 33.

The Latitude and Longitude of two Places given, to find their bearing and distance.

LET one place be A in the Latitude of 48°. 00′ N°. and Longitude of 20°. 00′ let the other place be B in the North Latitude of 50°, 00′ and Longitude of 22°. 00′.

Draw the line AB, which shall represent their nearest distance; then upon the line AF measure the distance AB, and you will find it to reach to D. so shall AD 2°. 48′. or 56 Leagues be the measure of AB, the distance required.

Also the line AB cuts the Quadrant in 4, which shews that the Course from A to B is 4 points from the North towards the East, that is NE.

Note AC is called the diff. of Latitude, and CB the difference of Longitude between these two Places.

PROP.

PROP. 2. Fig. 33.

The Courſe and Diſtance, between two Places, with the Latitude and Longitude of one of them given to find the Latitude and Longitude of the other place.

Let one place be A in the N° Latitude of 48°. 00 and Longitude of 20°. 00′. and let the Courſe given be NE, the diſtance of the two places upon the Courſe be 2°. 48′ or 56 Leagues.

Draw the NE line AB, and from the line AF take 2°. 48′, *viz* AD, which ſet from A to B, then from B draw the line CB, parallel to AF, ſo ſhall B be the ſecond place required, which by the Chart is found to lie in the N°. Latitude of 50°. 00′. and Longitude of 22°. 00′.

PROP. 3. Fig. 33.

Having the Latitude and Longitude of one Place, with the Latitude and bearing of another Place, to find the Longitude and diſtance of this ſecond Place.

Let one place be A in the N°. Latitude of 48°. and Longitude of 20°. 00′ let the other place lie in the N°. Latitude of 50°. 00′. the Courſe between theſe two being NE.

From C a point in the North Latitude of 50°. 00′. draw CB, parallel to AF, then from A draw the NE line A 4 B, to cut the Parallel of 50°. 00′ in B; So ſhall B be the ſecond place required; whoſe diſtance meaſured as in Prop. 1. of this Chap. is 2°. 48′. or 56 Leagues, and whoſe

Longitude

Longitude (by the Chart) appears to be 42°. 00′.

By this Prop. we may easily find how many miles or leagues a Ship must Sail upon any point of the Compass to raise or depress the Pole one Degree.

Thus let AE represent one Degree of Latitude from A, through each point in the Quarter of the Compass draw lines, to cut the parallel of the Latitude EH, as A 1. A 2. A 3. A 4. *&c.* which shall be the respective distances upon each point, for raising the Pole one Degree, and if AE be 60 miles, A 1. shall be 61 miles, A 2. 65 miles, A 3. 72 miles, A 4. 85 miles. A 5. 108 miles. A 6. 157 miles, A 7. 307 miles, and lastly, in Sayling East or West (which is the eight point) you neither can raise nor depress the Pole, because you always keep of an equal distance from it.

PROP. 4. Fig. 33.

The Longitude of two places, the Latitude of one of them, and the Course given, to find their distance, and the Latitude of the other place.

Let one place lie at A in the N°. Latitude of 48°. 00′ and Longitude of 20°. 00′. the other in the Longitude of 22°. the Course between them being NE.

From G a point in the Longitude of 22°. draw the line GB parallel to AI, then from A draw the NE line A 4 B to cut the parallel line GB in B. Lastly, from B draw BC parallel to AF, so shall the Chart shew that the place B lyes in the N°. Latitude of 50°. 00′. and AB applyed to

AE

AE will reach from A to D. hence it is evident that the diſtance between A and B is 56 Leagues.

PROP. 5. Fig. 33.

The Latitude of any two places and their diſtance given, with the Longitude of one of them, to find the Longitude of the other, and the Courſe from the one to the other.

Let one place be A in the No. Latitude of 48°. 00′ and Longitude of 20°. let the other place lie in the No. Latitude of 50°. 00′. the diſtance between them being 56 Leagues.

Out of the line AF take the diſtance given, *viz.* AD 56 leagues, or 2°. 48′ then from A with the diſtance AD croſs the Parallel of 50°. 00′. in B. Laſtly, draw the line AB, ſo ſhall it appear from the Chart that the place B lies in the Longitude of 22°. 00′. and that the Courſe from A to B is 4 points from the North Eaſtward, that is NE.

PROP. 6. Fig. 33.

The Longitude of any two places, the Latitude of one of them, and their diſtance given to find the Latitude of the other place and the Courſe between them.

Let one place be A in the No. Latitude of 48°. 00′ and Longitude of 20°. 00′. and let the other place lie in the Longitude of 22. 00′. the diſtance between the two places being 56 leagues.

Upon

Upon G a point in the Longitude of 22°. 00′. draw GB parallel to AI, then from the line AF take 2°. 48′. or 56 leagues, *viz.* AD, with which setting one foot in A, cross the line GB in B, and draw AB. Lastly, through B, draw BC parallel, to AF, so shall B be the second place required, whose Latitude is 50°. and from the Quadrant described upon A, it is evident that the Course from A to B is NE.

PROP. 7. Fig. 33.

To work a Traverse by the Plain Chart.

A Ship from the N°. Latitude of 50°. 00′. and Longitude of 20°. 00′ sayls NNE 26 leagues, NE, 30 leagues North 22 leagues, East 24 leagues, SE 26 leagues SSW 23 leagues, ENE 25 leagues, NE 27 leagues, and NNW 32 leagues, being bound to a Port lying in the N°. Latitude of 56°. and Longitude of 23°. 00′. I demand her latitude and longitnde, Course and distance run upon a strait line, and her bearing and distance from the Port.

Lay a Ruler upon A, and the NNE line, and from C by the side thereof, draw the line C ♈ parallel to it, then from AF take 26 leagues which set from C to ♈, that done, lay a Ruler upon A and the NE, and from ♈ draw ♈ ♉ parallel thereto, upon which set 30 leagues from ♈ to ♉ also from ♉ (because the next Course is North) draw ♉ ♊, parallel to AI, and set 22 leagues from ♉ to ♊ then from ♊ draw ♊ ♋ parallel to AF (because the Course is East) and set 24 leagues from ♊ to ♋, then lay a Ruler upon

upon I and the SE point of the Compaſs, and from ♋ draw a line parallel to the ſide thereof as ♋ ♌, upon which line ſet 26 leagues form ♋ to ♌, then lay a Ruler on E and the SSW point, and from ♌ draw the SSW line ♌ ♍ parallel to the ſide thereof, and ſet 23 leagues from ♌ to ♍, that done, lay a Ruler upon A and the ENE point, and from ♍ draw the ENE li e ♍ ♎ upon which ſet 25 leagues from ♍♎, alſo lay a Ruler on A and the NE point, and from ♎ draw ♎♏ parallel to the ſide thereof, upon which ſet 27 leagues from ♎ to ♏. Laſtly, lay a Ruler on F and on NNW point, and from ♏ draw ♏ ♐ parallel to the ſide thereof for a NNW line, and ſet 32 leagues from ♏ ♐: So have you finiſhed all the Courſes of the Traverſe.

To find the Ships Latitude, Longitude Courſe and Diſtance run upon a ſtraight line, do thus.

Draw the line C ♐, and from ♐ draw ♐ ♓ parallel to AF, ♐ ♒ parallel to FE, ſo ſhall the Chart ſhew you that the Ship is in the N. latit. of 54°. 24′. and longitude 24°. 42′. Alſo from C with the Radius AK ſtrike the Arch LM, which applied to the Quadrant KN will reach from K to R, hence it is evident that the Courſe from C to ♐ is NE 2°. 00′ Eaſtward, and the diſtance C ♐ meaſured upon the line EF or AI, will reach from F to O, *viz.* 6°. 24′. or 128 leagues.

To find the Courſe and diſtance between the Ship and Port, draw the line ♐ ♑, becauſe the Port lies at ♑ from ♐ with the diſtance AK ſtrike the Arch PQ, which meaſured upon the Quadrant KN will reach from K to R almoſt;

N hence

hence the Courſe from ♐ to ♑ is NW 1°. 47′. Weſt, and ♐ ♑ is their diſtance, which meaſured upon the line EF gives 2°. 19′. or 46 ½ leagues.

CHAP. XII.

Of Plain Sailing.

THE buſineſs of plain Sailing conſiſts in the Logarithmical ſolution of ſuch Triangles as are drawn upon the plain Chart. What the plain Chart is I have formerly declared, as alſo upon what Hypotheſis it is grounded: there remains nothing more to be done, but only to ſhew the Logarithmical ſolution of theſe Nautical Triangles, which are uſually divided into 6 following Caſes.

Before I undertake the ſolution of the ſix following Caſes, it will not be amiſs to premiſe theſe general Rules.

RULE I.

The Ship in North Latitude.

1. If the Courſe be Northward, ſhe raiſeth or elevateth the Pole, and therefore the diff. Latit. is

(redu-

(reduced into Degrees and Minutes) muſt be added to the Latitude, from whence the Ship came ; and that ſum ſhall be the Ship's true Latitude North

2. If the Courſe be Southward ſhe depreſſeth the Pole, or decreaſeth her Latitude ; and then the diff. Latitude in Deg. and Min. muſt be ſubtracted from the Latitude ſhe departed ; and the Remainer ſhall be the Ship's Latitude North

3. If the Courſe be Southward, and the diff. of Latitude reduced into Degrees and Minutes exceed the Latitude ſhe came from ; ſubtract the ſaid Latitude from this reduced difference of Latitude, and the remainer ſhall be the Ship's Latitude South : and conſequently the Ship hath croſt the Equinoctial.

RULE 2.

The Ship in South Latitude.

1. If the Courſe be Southward, the Ship raiſeth the Pole, or encreaſeth her Latitude ; and then the diff. Latit. reduced into D. M. muſt be added to the Latitude from whence the Ship departed, and the ſum ſhall be the Ship's Latitude South.

2. If the Courſe be Northward, ſhe decreaſeth her Latitude;and therefore the difference of Latitude reduced into D. M. muſt be ſubtracted from the Latitude ſhe departed,and the remainer ſhall be the Ship's latitude South.

3. If the Courſe be Northward, and the diff. latitude reduced into D. M. exceeded the latitude ſhe came from, ſubtract this ſaid latitude from the reduced diff. of latitude, and the remainer ſhall be the ſhip's latitude No. and conſequently ſhe hath croſt the Equinoctial.

RULE 3.

Having the Latitude of any two Places given, to find the difference of Latitude.

1. If the two places lie both in the North, or both in South latitude, ſubtract the leſſer latitude from the greater; the remainer ſhall be the Difference of latitude in Degrees and Minutes.

2. If one place lie in North latitude, and the other in South latitude, add the two latitudes together, and the ſum ſhall be the diff. latitude in Deg. and Min.

The Reduction of degrees and minutes into miles (or leagues) both Sexagenary and Engliſh, was fully expreſſed in Chap. 10.

RULE 4.

To find whether you muſt Sail Northward or Southward, between any two places whoſe Latitudes are known.

1. If you ſail from a greater No. latit. to a leſſer, the Courſe is Southward; but if from a leſſer No. latitude to a greater, the Courſe is Northward.

2. If

2. If you ſail from a greater South latitude to a leſſer, the Courſe is Northward: but if from a leſſer South latitude to a greater, the Courſe is Southward.

3. If you ſail from a No. latitude to a South latitude, the Courſe is Southward: but if from a South latitude to a North latitude, the Courſe is Northward.

RULE 5.

To find the Ship's Longitude.

1. If the Courſe be Eaſtward, the longitude encreaſeth, and therefore the diff. longitude reduced into D. M. muſt be added to the longitude from which the ſhip departed, and the ſum ſhall be the ſhips preſent longitude: But if the Courſe be Weſtward ſhe decreaſeth her longitude; and therefore the diff. of longitude reduced into D.M. muſt be ſubtracted from the longitude ſhe departed, and the remainer ſhall be the ſhips preſent longitude.

2. If the Courſe be Eaſtward and the ſum of the ſhips longitude and reduced diff. longitude exceed 360°. ſubtract 360°. from this ſum, and the remainer ſhall be the ſhip's true Longitude, and conſequently the ſhip hath croſt the Firſt Meridian.

3. If the Courſe be Weſtward, and the diff. longit. reduced into D. M. exceed the longitude ſhe came from, ſubtract this ſaid longitude from this reduced diff. longit. and the remainer ſubtracted from 360°. ſhall give the ſhip's preſent longitude.

RULE 6.

Having the Longitude of any two Places given to find the diff. Longitude between them.

Subtract the lesser from the greater Longitude, and the remainer (being less than 180°.) shall be the diff. longitude required. But if this remainer exceed 180°. subtract it from 360°. and the remainer shall be the true diff. longitude in Deg. and Minutes.

RULE 7.

To find whether you must Sail Eastward or Westward, between any two places, whose Longitudes are known.

1. If you Sail from a lesser longitude to a greater, the Course is Eastward; but if from a greater to a lesser, the Course is Westward.

2. If you cross the first Meridian, and sail from a greater longitude to a lesser, the Course is Eastward; and if (crossing the first Meridian) you sail from a lesser to a greater longitude, the Course is Westward.

ANNOTATION.

Our Modern Geographers do many times place the first Meridian over the Metropolis of that Country wherein they were born; and thereby do distinguish the longitudes of places into

into Eaſt and Weſt longitude, accounting all thoſe places which lie to the Eaſtward of this Metropolitan Meridian to lie in Eaſt longitude: and all thoſe places which lie to the Weſtward thereof, to lie in Weſt longitude.

Hence it is evident that the Longitude of places thus diſtinguiſhed, cannot exceed 180 Degrees.

RULE 8.

The Ship in Eaſt Longitude.

1. If the Courſe be Eaſtward, ſhe encreaſeth her longitude, and therefore the different longitude reduced into Deg.and Min.muſt be added to the longitude ſhe came from, and the ſum ſhall be the Ship's longitude Eaſt: but if this ſum exceed 180 Degrees, ſubtract it from 360°. and the remainer ſhall be the Ship's longitude Weſt.

2. If the Courſe be Weſtward, ſhe decreaſeth her longitude, and therefore the diff. longitude reduced into Degrees and Minutes, muſt be ſubtracted from the longitude ſhe departed, and the remainer ſhall be the Ship's longitude Weſt.

3. If the Courſe be Weſtward, and the diff. longitude reduced into D. M. exceeds the longitude ſhe came from, ſubtract the ſaid longitude from the reduced diff. longitude, and the remainer ſhall be the Ship's longitude Weſt: and conſequently the Ship hath croſt the firſt Meridian.

RULE 9.

The Ship in West Latitude.

1. If the Courſe be Weſtward, the longitude encreaſeth, and therfore the diff. longit. reduced into D. M. muſt be added to the longitude ſhe came from; and the ſum being leſs than 180°. ſhall be the Ship's longit. Weſt. But if this ſum exceed 180°. ſubtract it from 360°. and the remainer ſhall be the Ship's longitude Eaſt.

2. If the Courſe be Eaſtward, the longitude decreaſeth, and therefore the diff. longit. reduced into D. M. muſt be ſubtracted from the longitude ſhe departed, and the remainer ſhall be the Ships longitude Weſt.

3. If the Courſe be Eaſtward, and the diff. longit. reduced in D. M. exceed the longitude ſhe came from, ſubtract the ſaid longitude from this reduced diff. longit. and the remainer ſhall be the Ship's longitude Eaſt, and conſequently the Ship hath croſt the firſt Meridian.

RULE 10.

The Longitude of any two places (diſtinguiſhed by Eaſt and Weſt Longitude) given, to find the diff. Longitude between them.

1. If the two places lie both in Eaſt, or both in Weſt longitude, ſubtract the leſſer from the greater, and the remainer ſhall be the diff. longitude in D. M.

2. If

2. If one place lie in Eaſt, and the other in Weſt longitude, add them together, and their ſum being leſs than 180°. ſhall be the diff. longitude between them. But if this ſum exceed 180°. ſubtract it from 360°. and the remainer ſhall be the diff.Longitude required.

RULE 11.

To find whether you muſt Sail Eaſtward or Weſtward, between any two places in Eaſt or Weſt Longitude.

1. If you ſail from a greater Eaſt longitude to a leſſer, the Courſe is Weſtward: but if from a leſſer to a greater Eaſt longitude, the Courſe is Eaſtward.

2. If you ſail from a greater Weſt longitude to a leſſer, the Courſe is Eaſtward: but if from a leſſer Weſt Longitude to a greater, the Courſe is Weſtward.

3. If you ſail from a place in Eaſt longitude to a place in Weſt longitude, the Courſe is Weſtward, except you croſs the firſt Meridian, and then the Courſe is Eaſtward, and the contrary.

RULE 12.

Having the angle of the Courſe, and Quarter of the Compaſs you have ſailed in, to find the Ship's Rumb.

Seek in the foregoing Table of Points in *Pag.* 161 for the neareſt whole point to the angle of the Courſe; and if the angle of the Courſe be greater than the neareſt whole point, then you have ſailed to the Eaſtward or Weſtward of that whole point.

But

But if the angle of the Courſe be leſſer than the neareſt the whole point, you have failed to the Northward or Southward thereof.

Examples of all theſe Rules follow in the enſuing Caſes.

PLAIN SAILING.

CASE 1. Fig. 34.

Courſe and Diſtance run, given to find the Ships Latitude and Longitude, by Plain Sailing.

A Ship from the North latitude 50°. 00′ and longitude of 70°. 00′. Sails NEBE 130 leagues. I demand her latitude and longitude.

GEOMETRICALLY.

Draw the line AB to repreſent the Ship's firſt Meridian, or North and South line. From A with the Chord of 60°. ſtrike the Arch DE, and from the ſame line of Chords take the angle of the Courſe, *viz.* 56°. 15′. which ſet from D to E, and draw the line AE.

From the line of equal parts take 130 leagues, which apply from A to C. Divide AC equally in F, and from F, with the diſtance AF croſs the Meridian

dian AB in B. Laſtly, draw BC, ſo ſhall AB be the diff. Latit. in leagues, and BC the diff. longitude in leagues, both which muſt be meaſured upon the line of equal parts.

LOGARITHMICALLY.
By Caſe 3 of Plain Triangles

℞. AC : : S, A : BC. that is,

As the Radius ſine of 90°.00′.*viz.* AC	1000000
Is to the diſtance run AC 130 leagues	211394
So is ſine of the Courſe, ang. BAC 56°.15′.	991984
To the diff. longit. in leagues BC 108	203378

This diff. longit. reduced into degrees and minutes, gives 5°. 24′. therefore by 1. Rule 5. the Ship (according to the Plain Chart) is in the longitude of 75°. 24′.

Again, ℞. AC : : S, C : AB. that is

As Radius AC, ſine of 90°. 00′.	1000000
Is to the diſtance run AC 130 leagues	211394
So is ſine of the angle ACB 33°. 45′,	974473
To the diff. Laitit. in leagues, AB 72.	185867

This diff. latitude reduced into Deg. and Min. gives 3°. 36′. therefore by 1. Rule 1. the Ship is in the North latit. 53°. 36′.

CASE 2. Fig. 35.
Both Latitudes and Courſe given, to find the Longitude and diſtance.

A Ship from the Equinoctial, and longitude of 2°. 10′. Weſt ſails NEBE to the latitude of 3°.

36'. N°. I demand her longitude and diſtance run.

GEOMETRICALLY.

Draw the line AB to repreſent the Ship's firſt Meridian or N°. and S°. line. From A with the Chord 60°. 00'. Strike the Arch DE, and from the ſame line of Chords take the angle of the Courſe, *viz.* 56°. 15'. which apply from D to E, and draw the line CA. By the Rule 3. it is evident that the diff. Latitude is 3°. 36'. which reduced into leagues make 72 leagues. From the equal parts take 72 leagues, which apply from A to B. Upon B erect the perpendicular BC, to cut the line AC in C. So have you finiſhed the plain ſailing Triangle ABC, in which AB is the difference of latitude, AC the diſtance run, and BC the difference of longitude required. All which muſt be meaſured upon the ſame line of equal parts.

LOGARITHMICALLY.

S C : AB : : R : A C, that is,

As ſine of the angle at C 33°. 45'.	974473
Is to the diff. latit. AB 72 leagues	185733
So is Radius AC ſine of 90°. 00'.	1000000
To the ſhips diſtance run AC 130 leag.	211260

Again,

Again, S, C. AB : : S, A : BC. that is,

As ſine of the angle C 33°. 45′.	974473
Is to diff. latitude AB 72 leagues	185733
So is the Sine of the Courſe an. BAC 56°.15.	991984
	1177717
To the ſhips diff. longit. BC 108 leag.	203244

This diff.longit.reduced into D.M.(by dividing it by 20 the leagues in one deg.) gives 5°. 24′.for the diff. longit. in D. M. therefore by 3. Rule 8. the ſhip is in the Eaſt longit. of 3°. 14′.

CASE 3. Fig. 36.

Both Longitudes and Courſe given, to find the Ships Latitude and Diſtance run.

A ſhip from the N°. latitude of 2°. 00′. and Eaſt longit. of 178°. 00′. ſails SEBE to the Weſt longit. of 176. 21. I demand her latitude and diſtance run.

GEOMETRICALLY.

Draw the line EC to repreſent the Ships diff. longit. from C with the Chord of 60°. 00′. ſtrike the Arch DE, upon which ſet the Complement of the Courſe *viz.* 33°. 45′ from D to E, and draw the line CE at length. Then by 2. Rule 10. find the ſhip's diff. longit. *viz.* 5°. 39′. or 113 leagues; which take from the line of equal parts, and ſet from C to B, upon B erect the perpendic. BA to cut the line CE continued, in A. So have you finiſhed the plain ſailing

ſailing Triangle ABC, in which AB is the diff. Latit. and AC the diſtance run.

LOGARITHMICALLY.

S, A : BC : : R. AC, that is,	
As ſine angle A 56°. 45'.	991984
Is to diff. longit. in leagues BC 113	205307
So is Radius AC, ſine of 90°. 00'	1000000
To the diſtance in leagues AC 136	213313
Again, S, A : BC :: S, C : AB. that is	
As ſine angle A 56°. 15'	991984
Is to diff. longit. in leagues BC 113	205307
So is Sine angle C 33°. 45'.	974473
	1179780
To the diff. latit. in leagues AB. 76	187796

which reduced into D. M. make 3°. 48', therefore by 3. Rule 1. the ſhip is in the South latit. of 1°. 48'.

CASE 4. Fig. 37.

Both Latitudes and diſtance run, given to find the Courſe and Ship's Longitude.

A ſhip from the South latitude of 28°. 00'. and longitude of 358°. 00'. is bound for a Port in the South latit. 51°. 10' diſtant from her 136 leagues to the Eaſtward. I demand her Courſe, and longitude of the Port.

GEO-

GEOMETRICALLY.

Draw AB for the Meridian the Ship comes from, and by 1. Rule 3. find the diff. latitude, *viz.* 3°. 30′. or 70 leagues, then by 2 Rule 4 ſet this reduced diff. latit. from A to B. Upon B erect the perpendicular BC. Take the diſtance given, in your Compaſſes, and with one foot in A croſs the line BC in C, then draw AC, and from A with the Chord of 60°. ſtrike the Arch DE, So have you finiſhed the Plain Sailing Triangle ABC, whoſe parts are eaſily known.

LOGARITHMICALLY.

AC. R : : AB : S, C. that is

As the diſtance run AC 136 leagues	213353
Is to Radius AC Sine of 90°. 00′.	1000000
So is the diff. latitude AB 70 leagues	184509
To ſine of the angle at C 30°. 58′.	971156

which ſubtracted from 90°. 00′. the remainer 59°. 2′ is the angle of the Courſe, *viz.* CAB, therefore by Rule 12, the Courſe from A to C is SEBE 2°. 47′ Eaſtward.

Again, R. AC : : S, A : BC. that is.

As Radius AC. ſine of 90°. 00′.	1000000
Is to diſtance run AC 136 leagues	213353
So is ſine of the angle at A 59°. 2′	993321
To diff. longitude in leagues BC 116	206674

which

which reduced into D. M. gives 5°. 48′. therefore by 2. Rule 5. the Ship is in the Longitude of 3°. 48′.

CASE 5. Fig. 38.

Both Longitudes and distance run given, to find the Course and Ship's Latitude.

A Ship from the North latitude of 46°. 00′. and longitude of 2°. 00′. fails between the North and West 120, to the longitude of 357. I demand her Course and latitude.

GEOMETRICALLY.

Draw the line CB, and by Rule 6 find the Ship's diff. longitude, which is 5°. 00′. this reduced into leagues makes 100, therefore set 100 leagues from C to B. From B let fall the perpend. BA. Take 120 leagues (the Ship's distance run) in your Compass, and with one foot in C, cross the perpend. BA in A. Draw the line CA, and from A with the Chord of 60°. strike the Arch DE, which measured upon the same line of Chords, gives 56°. 27′. for the angle of the Course. Therefore by Rule 12, the Ship's Course is NWBW 00°. 12′. Westward.

LOGA-

LOGARITHMICALLY.

AC: R:: BC: S. A. that is,

As the diſtance run AC 120 leagues	207918
Is to Radius AC, Sine of 90°. 00'.	1000000
So is the diff. longitude BC 100 leagues	200000
To Sine Ang. of the Courſe BAC 56°. 27'.	992082

Again, S, A : BC :: R : AC, that is,

As Sine Angle A 56°. 27'.	992082
Is to diff. longitude BC 100 leagues	200000
So is Sine Angle C 33°. 33'.	974246
	1174246
To the diff. latitude AB 66 leagues	182164

which reduced into D. M. make 3°. 18'. Therefore by 1. Rule 1. the Ship is in the N°. latitude of 49°. 18'.

CASE 6. Fig. 39.

Both Latitudes and both Longitudes given, to find the Courſe and diſtance.

Admit there be two ſeveral Ports, the one in the North latitude of 52°. and longitude of 58°. 00'. the other in the North latitude of 48°. and longitude of 53. 00. I demand the Courſe and diſtance between them.

GEOMETRICALLY.

By 1. Rule 3. find the diff. latitude, *viz.* 4°. 0′. or 80 leagues, and by 1. Rule 4. you will find the Course to be Southward; therefore draw the line AB, and set 80 leagues from A to B. Also by 6 Rule find the diff. of longitude, *viz.* 5°. 0′. or 100 leagues, and by 1. Rule 7 it is evident the Course must be Westward. Therefore from B draw BC perpend. to AB. upon which set 100 leagues from B to C, then draw the line AC which shall be the distance between the two Ports. Lastly, from A with the Chord of 60°. strike the Arch DE which shall give the measure of the Angle of the Course.

LOGARITHMICALLY.

AB : R : : BC : t, A. that is,

As the diff. latitude AB 80 leagues	190309
Is to Radius AC, Sine of 90°. 00′.	1000000
So is diff. longitude BC 100 leagues	200000
To Tang. of the Course, ang. BAC. 51.21	1009691

Therefore by Rule 12. the Course will be SW 6°. 21′. Westward, or SWBW 4°. 54′. Southward.

Again, S, A : BC : : R : AC. that is,

As Sine angle of the Course 51°. 21′.	98926
Is to diff. Longitude BC 100 leagues	20000
So is Radius AC. Sine of 90 . 00′.	100000
To the distance run AC 128 leagues	21073

To work a Traverse by Plain Sailing.

FIG. 40.

A Ship from the North latitude of 24°. 30'. and East longitude of 48°. 40'. is bound for a Port in the North latitude 27°. 06'. and East Longitude 51. 34. she sails NNW 21, North 20. NNE 24, NE 25, East 37, NWBN 32. South 48, and SEBS 47 leagues. I demand her latitude, longitude, course and distance run upon a streight line, and her bearing and distance from the Port.

GEOMETRICALLY.

Draw the line YAX for an East and West line. Upon A erect the perpendicular AZ for a North and South line. From A (with any distance) strike the semicircle, which divide into 16 equal parts, to represent the several Points of the Compass: Lay a Ruler upon A, and on each of these 16 Points, and draw lines A 1. A 2. A 3. as in the Figure.

Then because the first course is NNW 21 leagues, take 21 leagues from the line of equal parts, and set the same from A to B. Lay a Ruler upon A Z, and from B draw a line parallel to

the side thereof as BC, to represent a N°. line. Upon this line set 20 leagues from B to C. Also lay a Ruler on the NNE line A 2, and from C draw a line parallel to the side thereof as CD, for a NNE line, upon which set 24 leagues from C to D. Again, lay a Ruler upon the NE line A 4, and from D draw a line parallel to the side thereof, as DE, upon which set 25 leagues from D to E. Then lay a Ruler upon the East line YAX, and from E draw a line parallel thereto as EF, upon which set 37 leagues from E to F. Also lay a Ruler upon the NWBN line A 3, and from F draw F G parallel thereto, upon which set 32 leagues from F to G; lay a Ruler upon the South line ZA, and from G draw GH parallel thereto; upon which set 48 leagues from G to H. Lastly, lay a Ruler upon the SEBS line, or rather its opposit, the NWBN line A 3, and from H draw HI parallel thereto, upon which set 47 leagues from H to I. So have you finished the Traverse. Then to find the ship's diff. latitude, *&c.* draw the line AI, which divide into two equal parts in M. From M with the distance AM cross the line AZ in N. So shall AN be the ship's diff. latitude, NI her diff. longit. AI her distance run, and NAI the angle of her course; all which may be measured upon the line of equal parts, and Chords.

To protract the Port, you must by 1. Rule 3. find the diff. latitude between the two Ports, *viz.* 2°. 56'. or 52, Leagues and by 1 Rule 10 find their diff. longitude, *viz.* 2°. 54'. or 58 leagues, which being known, set 52 leagues from A to O. Draw OK parallel to AX, and upon OK set 58 leagues from

from O to K. Then draw I K, which ſhall be the diſtance between the Ship and Port. Alſo continue OK to L, making OL equal to NI. Laſtly draw IL, ſo ſhall IL be the diff. latitude between the ſhip and Port, and KL the diff. longitude between them.

ARITHMETICALLY.

The Ship's Latitude and Longitude may be moſt expeditiouſly found in the Traverſe Tables, whoſe uſe I have explained immediately before the Tables; and ſo the diff. latitude and longit. upon each courſe and diſtance for the foregoing Traverſe will be as followeth.

Courses	Leagues	Miles	Miles Northing	Southing Miles	Miles Easting	Miles Westin.
NNW	21	60 3	55433 2771			22961 1148
North	20	60	60000			
NNE	24	70 2	64672 1848		126788 0765	
NE	25	70 5	49498 3535		49498 3535	
East	37	100 11			111000	
NWBN	32	90 6	74832 4988			50001 3333
South	48	100 40 4		144000		
SEBS	47	100 40 1		83147 33259 0831	55557 22223 0555	
			317.577	261.237	269.921	77.443

Thus it appears that the ſum of the Northing Column is 317. 577 miles; of the Southing 261. 237 miles; of the Eaſting 269. 921 miles, and of the Weſting 77. 443 miles. Subtract the ſum of the ſouthing Column from the ſum of the northing Column, the remainer 56. 34 miles is the Ship's diff. Latitude; therefore by 1. Rule 1. the Ship is in the North Latitude 25°. 26′.

Alſo

Also (because the Westermost Column is the least) subtract 77. 443. the sum of the Westerly Column, from 269. 921 the sum of the Easterly Column, the remainer 192. 478 is the number of Miles in the diff. of Longitude; therefore by 1. Rule 8. the Ship is in the East Longitude 51°. 52.

To find the Ships Course and distance run upon a straight line, say by Case 6. plain Sailing.

As the diff. Latit. 56. 34 miles AN —1750817
Is to Radius Sine of 90°. 00′.——— —10 000000
So is the diff.Longitude 192. 48 miles IN 2284385

To Tang. ship's Course 73°. 41′. NAI--10533568

As Sine of the Course 73. 41. NAI 9982146
Is to diff. Longitude 192. 48. miles IN 2284385
So is Radius Sine of 90°. 00′. ——— — 10000000
AI ———
To the ship's distance run 200. 57 Miles 2302154

By Rule 12. it is evident that the ship's Course is ENE 6°. 11′ Easterly, or EBN 5°. 4′. Northward.

By 1. Rule 3. if you subtract the ship's diff. Latitude AN from the Ports diff. Latitude AO, the remainer will be NO 99. 66. Miles, the diff. Latit. between the Ship and Port, equal to IL.

Also by 1. Rule 8. if you subtract the Ports diff. Longit. OK from the ship's diff. Longit. NI, the remainer 18. 48. Miles equal to KL will be the diff. Longit. between the ship and Port.

Then to find the Courſe and diſtance from the Ship to the Port, ſay

As diff. lat. bet. Ship and Port, IL 99.66.	1998521
Is to Radius Sine of 90°. 00′.	10000000
So is diff. long. bet. Ship & Port KL 18.48	1266702
To Tang. angle KIL 10°. 31′.	9268181

As Sine angle KIL 10°. 31′.	9261314
Is to Radius Sine of 90°. 00′.	10000000
So is diff. longitude KL 18. 48.	1266702
To diſt. bet. the Ship and Port 101.2.M.	2005388

Therefore by Rule 12. the Courſe from I to K is NBW 00°. 44′. North.

CHAP. XIII.

The Solution of Plain Sailing Queſtions, by the (ſo called) Tables of given Numbers.

THE Table of given Numbers is nothing elſe but a Table of Natural Sines and Tangents anſwering to each point, ½ point and ¼ point of the Compaſs.

A

A Table of Naural Sines and Tangents to every Point, ½ Point and ¼ Point of the Compass.

Points.	Sines	Points.	Sines	Points.	Tang.	Points.	Tang.
	49		741		44		1103
	98		773		98		1218
	147		803		148		1348
1	195	5	831	1	199	5	1496
	243		858		250		1668
	290		882		303		1870
	337		904		358		2188
2	383	6	924	2	414	6	2414
	428		941		473		2795
	471		957		533		3249
	515		970		599		3991
3	555	7	981	3	668	7	5112
	596		989		742		6749
	634		995		82[illegible]		10138
	671		999		906		20205
4	707	8	1000	4	1000	8	Infinite.

The use of this Table.

CASE I.

Course and Distance given, to find the Ships diff. Latitude and Departure.

A Ship Sails NEBE 120 leagues, I demand her diff. Latitude and departure.

1. Multiply the distance run 120 by the Sine of the Course 831. that Product 99720 divided by 1000, the Quotient 99. 720 leagues is the departure.

2. Multiply the distance run 120 by the Compt. of the Course 555, that Product 66600 divided by 1000 gives 60. 6 for the difference Latitude.

Note, Seeing that the Longitudes of Places cannot be truly exprest upon the Plain Chart, because the Construction thereof depends upon a false Hypothesis, therefore what I called in the preceding Problems, by the name of difference of Longitude, ought rather to be called departure or Easting and Westing; because it only shews the distance of any two Meridians in any Parallel of Latitude, but not the same distance of those two Meridians at the Equinoctial.

CASE

CASE 2.

Course and diff. Latitude given, to find the departure and distance run.

A Ship sails NNW till her diff. latitude be 75 leagues. I demand her departure and distance run.

1. Multiply the diff. latitude 75 by the Sine of the Course 383, that Product 28725 divided by the Co-sine of the Course 924, gives 31 leagues for the departure.

2. Multiply the diff. latitude 75 by 1000, that Product 75000 divided by the Co-sine of the Course 924, gives 81 leagues for the diff. latitude.

CASE 3.

Course and Departure given, to find the Ship's diff. Latitude and distance run.

A Ship sails NWBN till her departure be 78 leagues. I demand her diff. Latitude and distance run.

1. Multiply the departure 78 by 1000, that Product 78000 divided by the Sine of the Course 555, gives 140 leagues for the distance run.

2. Multiply the departure 78, by the Co-sine of the Course 831, that Product 64818 divided by the Sine of the Course 555, gives 116 for the diff. Latitude.

CASE

CASE 4.

Distance run and diff. Latitude given, to find the Course and Departure.

A Ship sails between the North and the East 120 leagues, till her diff. latitude be 66. 60 leagues. I demand her Course and Departure.

1. Multiply the diff. latitude 66. 60 by 1000. that Product 666000 divided by the distance run 120, gives 555, which seek for in the foregoing Table, and you will find answering thereto, 3 points of the Compass of the Course, then (because each quarter of the Compass contains 8 points) Subtract three points from eight points, the remainer will be five points. So the Course required will be NEBE.

2. Multiply the diff. Latit. 66. 60 by the Sine of the Course 831, that Product 553446 divided by the Co sine of the Course 555, the Quotient 99. 7 is the departure required.

CASE 5.

Distance run and Departure given, to find the Course and diff. Latitude.

A Ship sails 120 leagues S Eastward, till her departure be 99. 72 leagues. I demand her Course and diff. Latitude.

1. Multiply the departure 99. 72 by 1000, that Product 9972000 divided by the distance run 120, gives 831 the Sine of 5 points for the Course required.

2. Multi-

2. Multiply the departure 99. 72 by the Co-ſine of the Courſe 555, that Product 5534460 divided by the Sine of the Courſe 831, gives 66. 6 for the diff. Latit. required.

CASE 6.

Diff. Latitude and Departure given, to find the Courſe and diſtance run.

A Ship ſails S Eward till her different Latitude be 66. 6 Leagues, and her departure be 99. 72 Leagues. I demand her Courſe and diſtance run.

1. Multiply the departure by 1000, that Product 9972000 divided by the diff. Latitude 66. 60, gives 1496 for the Tangent of the Courſe, which is 5 points.

2. Multiply the departure 99. 72 by 1000, that Product divided by the Sine of the Courſe 831, gives 120 Leagues for the diſtance required.

CHAP.

CHAP. XIV.

The Solution of all the Cases in Plain Sailing by Natural Arithmetick.

BEfore you proceed to the ſolution of any Plain Sailing Queſtion, you muſt find whether difference of latitude or departure be the longeſt ſide in that Triangle: and this may be known from theſe following Rules.

1. If the Courſe be leſs than 4 points from the North or South, the diff. latitude is greater than the departure.

2. If the Courſe be more than 4 points from the North or South, the diff. latitude is leſs than the departure.

3. If the Courſe be juſt 4 points, the difference of latitude and departure are both equal: Which being known——

If the diff. latitude be the leſſer ſide, it muſt contain 1.0000. If the departure be leſs, it muſt contain 1.0000.

RULE.

1. Always divide 172 (with a competent Number of Cyphers annexed,) by the degrees and Decimal parts of a Degree contained in the Angle oppoſit to the leſſer ſide.

2. From

2. From the Square of this Quotient, you muſt always ſubtract 3, and out of the remainer extract the Square root.

3. Subtract this Square root from the double of the Quotient $\frac{1}{2}$ of this remainer ſhall be the diſtance run.

4. Subtract the double of the diſtance run from the ſaid Quotient, the remainer ſhall be the diff. latitude or departure according to that Scale whereby the leſſer ſide contained 10000.

And thus you may find the three ſides of this Nautical Triangle, the leſſer ſide being aſſumed 1.0000.

But becauſe in this way of ſolving plain ſailing Queſtions, it is neceſſary that all the Sexagenary minutes in a Degree be reduced into Decimals, I ſhall here ſhew the way of reducing them.

If 60′ — 10000 — 1   If 60′ — 10000 — 15′

1.   15

6 (10000) 0 (.166   6) 15000 | 0 | 2500

44   3 | 0 |

And by this proportion was the following Table calculated, which ſhews how many decimal parts are contained in any number of minutes, the Degree or Integer being ſuppoſed to be divided into 10000 parts.

A Table shewing the Reduction of Minutes into Decimals, and the Contrary.

M.	Decimals	M.	Decimals	M.	Decimals	M.	Decimals
1	.0167	16	.2667	31	.5167	46	.7667
2	.0333	17	.2833	32	.5333	47	.7833
3	.0500	18	.3000	33	.5500	48	.8000
4	.0667	19	.3167	34	.5667	49	.8167
5	.0833	20	.3333	35	.5833	50	.8333
6	.1000	21	.3500	36	.6000	51	.8500
7	.1167	22	.3667	37	.6167	52	.8667
8	.1333	23	.3833	38	.6333	53	.8833
9	.1500	24	.4000	39	.6500	54	.9000
10	.1667	25	.4167	40	.6667	55	.9167
11	.1833	26	.4333	41	.6833	56	.9333
12	.2000	27	.45[illegible]0	42	.7700	57	.9500
13	.2167	28	.4667	43	.7167	58	.9667
14	.2333	29	.4833	44	.7333	59	.9833
15	.2500	30	.5000	45	.7500	60	.10000

CASE I.

Course and distance run given, to find the diff. Latit. and Departure.

A Ship sailes NEBE 146 Miles, I demand her diff. Latit. and departure.

By the 2*d*. of this Chap. it is evident that the diff. Latit. is less than the departure, and therefore must be assumed 1. 000. Also by the forego-

ing

ing Table you find .75 is the Decimal of 45′. Therefore

```
33°. 75 | 172.00000 | 5096 Quot.      5.096
          305750   |    2             5.096
          0100       ———             ———
                    10.192 Q.doub.   30576
22.969216 | 4.792 Square root.       45864
16        |                          254800
87 | 696
   | 609                 Quot. squared 25.969216
———                             subtract  3
949 | 8792                               ———
    | 8541                remains 22.969216
———                                       ———
9582 | 25116
     | 19164
———
.5952
```

From the Quotient doubled —————— 10.192
Subtract the Square root —————— 4.792

Remains —————————— 5.400

⅓ of the remainer is the distance ———— 1.800

The distance doubled is —————— 3.600
Which subtracted from the Quotient ——— 5.096

The remainer is the departure ———— 1.496

Thus the three sides of this Triangle are found, whose lesser side is assumed 1.000. which being,

 known

known, we may by 4. 6. *Euc.* or by the Rules in Page 36. 37, find the reſponding proportional numbers for the ſides of the Triangle required. For

If the ſuppoſititious diſtance 1. 8, require 146 Miles, the ſppoſititious diff. Latit. 1.000 ſhall require 81. 1 Miles, and the ſuppoſititious deture 1.496 ſhall require 121. 34 Miles.

CASE 2.

Courſe and diff. Latitude given to find the diſtance run and departure.

A Ship ſails SEBS till her diſt. Latit. be 144 Miles. I demand her diſtance run and departure.

Here the departure is the leſſer ſide, and therefore muſt be aſſumed 1. 000. and the angle opſit to it is 33.75. Therefore divide 172. 00000 by 33.75. the Quotient is 5. 096, whoſe double will be 10.192 as afore, and the ſquare thereof will be 25. 969216. Therefore

From the Quotient doubled	10.192
Subtract the ſquare root	4.792
The remainer is	5.400
$\frac{1}{3}$ whereof is the diſtance as afore	1.800
The diſtance doubled makes	3.600
Which ſubtracted from the Quotient	5.096
The remainer is the diff. Latitude	1.496

Thus

Thus in these two Examples, the Course in the one, is equal to the Complement of the Course in the other, therefore (though the suppostitious distance in both is 1.8) yet the diff. Latit. in the first Example is equal to the suppostitious departure in the second, and the contrary. Then proceed as followeth,

If 1. 496 — 144 — 1. 800
18.00

115200
144

1.496 | 2592.00 | 173 Distance required.
1496

10960
10472

4880
4488

392

If 1.496 —— 144 —— 1.000
1.000

1.496 | 144.000 | 96 Depart. requir.
134.64

.9360
8976

384

CASE 3.

Courſe and departure given, to find the diff. Latitude and diſtance run.

A Ship ſails SSW till her departure be 50 Miles. I demand her diff. Latitude and diſtance run.

The angle of the Courſe is leſs than 4 points, and being always oppoſit to the departure, the departure muſt be the leſſer ſide, and conſequently is accounted 1.000.

```
22.5 | 172.0000 | 7.644 Quot.                 7.644
     | 1575     |   2                          7.644
     ---------  ------------               ----------
       1450      15.288 doublad              30576
       1350      ------------               30566
     ---------                              45864
       1000                                53508
        100                               ----------
     ---------   Square of the Quot.  58.430736
       1000      from which ſubtract  -3
                                      ----------
55.430736 | 7.445 Remainer is- - - -55.430736
49                                    ----------
------
144  | 643
     | 576
1484 | 6707
     | 5936
     ---------
1488 | 77136
     | 74424
     ---------
       2711
```

From

From the double Quotient ———— 15.288
Subtract the square root ———— 7.445

Remainer is ———— 7.843

½ whereof is the suppsititious distance — 2.614
2

The double distance is ———— 5.228
Which subtract from the Quotient. ——— 7.644

The remainer is the supposit. diff. Lat. —— 2.416

If 1.000—50—2.614
50

130.700 Dist. 130. 7 Miles.

If 1.000 – 50 – 2.416
50

120.800 diff. Latit. 120.8 Miles.

CASE 4.

Distance run and diff. Latit. given, to find the Course and Departure.

A Ship sails 120 Miles, till her diff. Latit. be 81 Miles. I demand her departure, and Angle of the Course.

These three following Cases do depend upon 47. 1. *Euc.* where it is demonſtrated that in a Right-angled plain Triangle, the ſquare of the Hypothenuſal is equal to the ſquare of the Baſe and ſquare of the Perpendicular added together.

Therefore ſquare the diſtance 120, which is 14400, alſo ſquare the diff. Latit. 81. which is 6561. then

From the ſquare of the diſtance	14400
Subtract the ſquare of the diff. Latit.	6561
The remainer is	7839

The ſquare root of which is the departure.

```
 7839.00 | 88.5 Departure in Miles.
 64
 -------
168   1439
      1344
      ----
1765  9500
      8825
      ----
       675
```

To find the Courſe.

To the diſtance run add ½ the departure (if the departure be greater than the diff. Latit.) or ½ the diff. Latit. (if that be greater than the departure.)

The diſtance run 120. to which ad[illegible] the departure 44. 25, the ſum is 164. [illegible] ſay.

If

If 164. 25—81—86 to the Comp. of the Course

```
                 81
              ------
                 86
               688
          ----------
  164.25 | 6966.0000 | 42.41
         | 65700    |
          ----------
             39600
             32850
            -------
              67500
              65700
            -------
               18000
               16425
             -------
                1575
```

In the Table for reducing Decimals into Minutes, seek for 41, and the responding number shews about 25 Minutes; so that the Compleat angle of the Course is 42°. 25′. therefore the true angle of the Course is 47°. 35′.

CASE 5.

Distance run and Departure given, to find the diff. Latitude and Course.

A Ship sails 146 Miles till her departure be 108 Miles. I demand her diff. Latitude and Course.

From the Square of the distance, subtract the Square of the departure, the Square root extracted out of the remainer gives the diff. Latitude.

108 146
108 146

9652 | 98 diff. Latit.
81

864 876
1080 584

188 | 1552
| 1504

11664 146

48

From 21316

take 11664

9652

Or thus, to find the diff. Latitude.

Multiply the sum of the distance run and Departure by their diff. the Square root of that Product shall be the diff. Latit.

146
9652 | 98 diff. Lat. 108
81

Sum 254
188 | 1552 diff. 38
| 1504

2032
48 762

Prod. 9652

To

To find the Course.

To the distance run — — — — — 146
add ½ the departure (being the greatest side) 49

Sum is — — — — — 195

As that sum 195—98 diff. Lat.—86 to Co-S. Course.

86
—
588
784
—
195 | 8428.00 | 43.22 ° or 13 Min.
780 | 100
—
.628
585
—
.430
390
—
.400
390
—
10

Here the Comp. of the Course is 43°. 13′. which subtracted from 90°. 00′. the remainder 46°. 47′. is the Angle of the Course required.

CASE

CASE 6.

Diff. Latitude and Departure given, to find the distance run and Course.

A Ship sails till her diff. Latitude be 86 Miles, and her Departure 104 Miles. I demand her distance run and Course.

To the Square of the diff. Latit. add the Square of the Departure, the Square root of that sum shall be the distance run.

```
                     86                      104
                     86                      104
                    ----                    -----
                    516                      416
                    688                     1040
                    ----                    -----
Diff. Latit. squared 7396  depart. squared  10816
        . . .      | 134. 9  dist.           7396
        18212      |                        -----
        1          |               sum      18212
      -------
   23 | 82
      | 69
     -------
  264 | 1312
      | 1056
     -------
 2689 | 256.00
      | 24201
     -------
        1399
```

To

To find the Angle of the Courſe.

To the diſtance run 134.9 and ; the Departure, *viz.* 54. the ſum is 188. 9. then ſay

As 188.9 is to diff. Latit. 86, ſo is 86 to Comp. Angle.

```
            86
          -----
           516
          688
          -----
  188.9 ) 7396.000 ( 39.15 Deg. or 39°.9'.
          5667
          ------
           17290
           17001
          ------
            2890
            1889
          ------
            10010
             9445
          ------
              565
```

Subtract 39°. 9'. from 90°. 00'. the remainer 50°. 51'. is the Angle of the Courſe.

The

The Solution of Oblique Triangles by Natural Arithmetick.

CASE I. Fig. 41.

Two sides with an Angle opposite of to one them, to find the other Parts.

A Ship at A obſerves an Iſland at B, bearing ENE, ſhe runs away NEBN 8 Miles to C. and then found the Iſland at B to be 6 Miles from her. I demand the Courſe from C to B and the diſtance between A and B.

From C let fall the Perpendicular CD, ſo have you reduced the oblique angled Plain Triangle into two right angled Plain Triangles, *viz.* ACD, called the firſt, and BCD the ſecond Triangle. In the firſt Triangle ACD, we have given the Hyp. AC, and the Angle at A, to find the Baſe AD, and the Perpend. DC, which may be done by the following Table.

A Table shewing the distance run, diff. Latit. or Dep. from every Point, ½ or ¼ Point of the Compass.

Angle of the Course in Degree and Decimal parts.	*Distance.*	*Diff. Lat. or Departure*
2. 8125	20. 39	20. 37
5. 625	10. 21	10. 15
8. 4375	6. 82	6. 74
11. 25	5. 13	5. 03
14. 0625	4. 14	3. 87
16. 875	3. 41	3. 37
19. 6875	2. 97	2. 797
22. 5	2. 614	2. 416
25. 3125	2. 340	2. 115
28. 125	2. 122	1. 871
30. 9373	1. 945	1. 669
33. 75	1. 800	1. 496
36. 5625	1. 678	1. 348
39. 375	1. 576	1. 218
42. 1875	1. 462	1. 153
45.	1. 000	1. 000

In this first Case of Obilques, seeing the Angle at A is 33. 75. you find against it in the Column of distance stands 1.8. and because the angle CAD is less than the angle ACD, therefore the side AD shall be greater than the side CD. But CD being the least side in the Triangle ADC, must be assumed 1.00, &c. and then the side AD will be 1.496. thus the three supposititious sides are known. Therefore say,

If

If AC 1.8—AC 8. what shall AD. 1.496.

```
           8 AC
     ----------
1.8) 11.968(6.64
     108
     ---
      116
      108
      ---
        88
        72
      ----
```

If AC 1.8 — AC 8 —— DC 1.000.

```
           8
     -------
1.8)8.000(4.44
    72
    ---
    80
    72
    ---
    80
    72
    --- DC
     8
```

To find the side BD we have given the Hyp.CB. and Perpend. CD. therefore by 47.1 *Euc.* from the Square of CB subtract the Square of CD. the Square root of the remainer is the length of the BD. which added to AD gives AB. As thus,

36.0000

36.0000 DC 4.44 CB 6
19.7136 BD 4.44 6

162864 | 402 1776 36
16 | 6.64 AD 1776
1776
803 | 2864 10.68 AB
| 2406 19.7136

455

To find the angle CBD, add the Hypothenusal CB and ½ of CD (which is the greater Leg) together: Then say,

CB.6
As 8.22. to BD 4.03 So is 86 ½ CD.2.22
86
Sum. 8.22
2418
3224
D.
8.22 | 346.58 | 42.16 or 42°. 10'
3288
100
1778
1644

1340
822

5180

Hence

Hence it is evident, that if you ſubtract 42°. 10′ from 90°. the remainer is 47°. 50′ for the angle at B.

CASE 2. FIG. 41.

Two ſides with their contained Angle given, to find the other Angles and the third ſide.

A Ship at B obſerves an Iſland at A bearing Weſt 9.8 Miles from her, ſhe ſails NWBW 7.6 Miles to C, I demand her bearing and diſtance from the Iſland.

Draw AB for an Eaſt or Weſt line, ſet 9.8 Miles from B to A, then draw a NWBW line as BC, upon which ſet up 6 Miles from B to C, laſtly draw the line AC.

Let fall the Perpend. CD, ſo ſhall CBD be the firſt Triangle, and ACD the ſecond. In the Triangle BCD, CD is the leſſer ſide, and muſt be aſſumed 1.000. Alſo in the preceeding Table CB is 1.8, and conſequently by the ſame Table BD muſt be 1.496. Therefore ſay,

```
     BC      BC      DC       DC
If  1.8 ——— 7.6 ——— 1.000 ——— 4.222.
              1.000
             ———————
   1.8 | 7.6000 | 4.222 DC.
       | 72     |
        ———————
          40
          36
          ——
           40
           36
           ——
            40
            36
            ——
             4
     BC      BC        BD         BD.
If  1.8 ——— 7.6 ——— 1.496 ——— 5.316
                      7.6
                    ———————
                     8976
                    10472
                   ————————
           1.8 | 11.3696 | 6.316
               | 108     |
               ———————————
                   56
                   54
                   ——
                    29
                    18
                   ———
                    116
                    108
                   ————
                      8
```

Q

Which

Which ſubtracted from BA9.8 the remainer 3.484 is DA. then in the ſecond Triangle ADC we have given AD. and DC. to find the Hypothenuſal AC. thus,

```
 .  .  .  .
29.963540 | 5.473 AC.
25
----
104|496
   |416
   ----
1087|8035
    |7609
    ----
10943|42640
     |32829
     ----
      .9811
```

```
DA-3.484        DC-4.222
   3.484           4.222
                  ------
   13936           8444
  27872           8444
 13936           8444
10452          16888
----          ------
12,138256      17.82528
----           12.138256
               ------
               29.963540
               ------
```

The angle may be found as in Caſe 1. of Obliques.

CASE 3. Fig. 42.

Three Sides given, to find the three Angles.

A Ship at A obſerves two Iſlands, the one at B bearing Eaſt 9.9 Miles from her; the other at C 7.6 Miles diſtant between the Eaſt and North but the two Iſlands were 6.6 Miles aſunder. I demand their bearing and the Courſe from A to C.

Dra

Draw the East line AB, upon which set 9.9 Miles from A to B, take 7.6 Miles in your Compasses, and with one foot in A strike the Arch C, then take 6.6 Miles in your Compasses, and from B cross the arch C in C. Draw the lines ACD and BC. Lastly from C with the distance BC strike the arch DBGF to cut AB in G, and AC in F, so shall AG be the alternate Base, AD shall be the sum, and AF the diff. of the two sides AC. CB.

To find the alternate Base, say,

As the true Base AB 9.9.
Is to Sum of the two sides AC.CB 14.2.
So is their diff. AF 1.0.
To the alternate Base AG 1.4.

Which subtracted from AB. the remainer is GB 8.5 the ½ whereof is EB 4.25. equal to EG. then to EG 4.25 add AG 1.4, the sum is AE 5.65. thus have we two right angled plain Triangles, *viz.* ACE. CEB. in either of which we have given the Hypothenusal and Base to find the angles, which you may effect by Case fourth and fifth of this Chapter.

CHAP. XV.

Of Currents.

I find none amongſt thoſe who have publiſhed any thing of Navigation, except in Mr. *Norwood*; where the buſineſs of Currents is tolerably handled. And he himſelf hath omitted to ſay any thing Prefatory in order to the compleat underſtanding thereof. Upon which account I thought the enſuing Precognita's might be ſerviceable to ſuch as are curious.

Firſt, One and the ſame Moveable may be agitated by many different and oppoſite motions at the ſame time. For if a Man be Walking on Board of a Ship, *viz.* directly Eaſt, while the ſame Ship is carried Weſtward, he admits of two motions; add to theſe two, the motion of the Sea it ſelf round the Earth, then it is evident that if the Sea, the Ship, and the Man do all move together, the Man admits of three motions.

Secondly, When any Moveable admits of many motions, two things are principally to be conſidered.

1. The *terminus à quo*, or the beginning of the motion; the *terminus ad quem*, or the end or ceſſation thereof.

2. Th

2. The line or way which this moveable deſcribes.

FIG. 43.

As to the *terminus à quo*, and *terminus ad quem*, let us ſuppoſe any moveable to be carried from A to B, and in the mean time let the whole plain (upon which that motion is performed) be ſuppoſed to move directly contrary to C: If then the moveable body move with the ſame celerity towards B, as the whole plain AB is moved towards C, that moveable ſhall always remain in the ſame place A. If the moveable body in paſſing from A to B, move more ſlowly than the whole plain AB doth towards C, then it ſhall (as Seamen uſually call it) loſe ground, or be carried towards C. But if it moves more ſwiftly towards B, than the whole plane AB doth towards C, then it gains ground, and is carried towards B; and always by the ſame proportion of celerity, by which the motion towards B, exceeds the motion towards C, or is exceeded by it. Laſtly, If a moveable be moved towards B, and at the ſame time the plain AB, upon which it moves, be carried alſo towards B; it is manifeſt, the moveable in paſſing from A to B, is carried more ſwiftly towards B, than by its ſimple motion could be effected.

As to the line which any moveable deſcribes, when it is affected with diverſe motions, it is ſometimes a right line, ſometimes the circumference of a Circle, ſometimes a particular Section of a Cone, ſometimes a Spiral, *&c.* and there is

no kind of lines which can be aſſigned, but may be deſcribed by certain compound motions.

FIG. 44.

Let ABCD be a Parallelogram: Upon the ſide AB let a Fly be ſuppoſed to move equally from A to B: And at the ſame time, let the ſide AB be ſuppoſed to move equally (with the Fly upon it) between the lines AB.DC. in ſuch manner that the ſide AB in its motion towards DC ſhall always be parallel to the ſide DC. I ſay, that the Fly by this twofold motion deſcribes the line AD.

Firſt, Let us ſuppoſe the motion of the Fly and that of the plain to be equal: That is, for every Inch the Fly moves from A towards B, let the plain AB be ſuppoſed to move an Inch towards CD, and that theſe two motions be performed in the ſame time: Then it follows, that while the Fly is moving from A to B, the plain AB is moved from AB to EF, and the point B is moved to F. Therefore the Oblique line AF is the line which the Fly deſcribes by that motion.

Again: Let us ſuppoſe the Fly to move more ſwiftly than the plain; that is, in the ſame time that the Fly moves from A to I, let the plain AI be moved to GH. Then it appears that the motion of the Fly is performed upon the line AH. Laſtly, Let us ſuppoſe the plain to move more ſwiftly than the Fly; that is, in the ſame time that the Fly moves from A to B, the plain AB is moved to DC, and therefore the line of the Flies compound motion is AD. And here note, That the

the point A is called the *Terminus à quo*, and the point D, the *Terminus ad quem*.

This may ſuffice for an Introduction to the Explication of the Nature of Currents; and from hence it is eaſie to conceive, that a Ship ſailing where there is a Current, hath a compound motion ariſing of two different Principles, *viz.* that of the Current, and that of the Ship; and from theſe two proceeds a third, which is the Ship's compound motion. Theſe three different kinds may for diſtinction be thus called.

The firſt may be called, the way or ſimple motion of the Current. The ſecond, the way or ſimple motion of the Ship; and the third may be called the line of the Ship's true motion.

Whence obſerve, That if the motion of the Current, and that of the Ship be both Rectilinear (as we ſuppoſe them to be in all the following Problems) the third alſo will be a right line, as may appear from *Fig.* 44. In which Figure you may note, That if the line AB repreſents the Ships ſimple motion, and the line BD the ſimple motion of the Current, and the line AD the Ships compound motion, then the angle BAD is called the angle of Deflexion, and the angle ADB the angle of Reflexion.

PROB. 1. Fig. 43.

Admit a Current runs Eaſt 6 Miles an hour, and a Ship ſails Weſt directly againſt it 6 Miles an hour. I demand her compound motion.

Let the Current run directly East from A to B, and the Ship directly West from B to A, it is evident, that the Ship makes no way but stands still in the same place: For so much as she is forced forwards by the Wind, so much she is driven backward by the motion of the Current. Therefore,

$$\left.\begin{array}{lr} \text{From the Ships simple motion} & 6 \\ \text{Subtract the motion of the Current} & 6 \\ & \text{--} \\ \text{The remainer is the Ships motion} & 0 \end{array}\right\} \text{Miles.}$$

PROB. 2. Fig. 43.

Admit a Current runs East four Miles an hour, and a Ship sails West directly against 6 Miles an hour. I demand her compound motion.

It is evident that if the Ships motion exceeds the motion of the Current, the Ship advanceth nearer towards B. Therefore

$$\left.\begin{array}{lr} \text{From the Ships simple motion} & 6 \\ \text{Subtr. the simple motion of the Current} & 4 \\ & \text{--} \\ \text{Remains the Ships compound motion} & 2 \end{array}\right\} \text{Miles.}$$

PROB. 3 Fig. 43.

A Current sets West 8 Miles an hour, and a Ship sails East directly against it 5 Miles an hour. I demand her compound motion.

Here

Here it is evident that becauſe the Current moves faſter than the Ship, the Current muſt force the Ship backwards, tho' by the Log line ſhe appears to gain ground. Therefore

From the Currents ſimple motion--8
Subtract the Ships ſimple motion---5 } Miles.
Remains the Ships comp. motion — 3

And thus the Ship falls a Stern 3 Miles every hour.

PROB. 4. Fig. 43.

A Ship ſails Eaſt 4 Miles an hour, upon a Current, which ſets Eaſt 5 Miles an hour. I demand her compound motion.

Here it is evident, that ſeeing the motion of the Ship, and that of the Current are both one way, therefore the Ships motion is accelerated by that of the Currents. So that you muſt

Add the Currents motion ———————5
To the Ships ſimple motion-—————4 } Miles.
That Sum is the Ships comp. motion----9

PROB. 5. Fig. 44.

A Ship ſails South 3 Miles an hour, where there is a Current running Eaſt 5 Miles an hour. I demand the Ships compound motion, and which way.

Let AB reprefent the Ships fimple motion, BD the Currents fimple motion, and AD the Ships compound motion. Then in the Triangle ABD we have given AB 3, and BD 5, to find the angle of Deflexion BAD, and the Ships compound motion AD.

As the Ships fimple motion AB. 3- —— 047712
Is to the Currents fimple motion BD. 5 —— 069897
So is Radius —— —— —— 90.00 — 1000000

To Tangent angle Deflex. BAD.-59.02 – 1022185

As fine angle Deflex. BAD—-59.02—-993321
Is to the Currents motion BD —— 5 —— 069897
So is Radius—— —— —— ——90.00-1000000

To Ships compound motion BD--5.8 Mil. 076576

Hence it appears, that the Ships Courfe is SEBE 2°. 47′ E, and her horary motion is 5. $\frac{8}{10}$ Miles.

PROB. 6. Fig. 44.

A Ship fails Eaft 4 days together, by Log. 480 Miles, where there is a Current fetting all this while to the Southward $2\frac{1}{2}$ Miles each hour. I demand her angle of Deflexion and compound motion.

To find how many Miles the Current hath run in 4 days, multiply 24 (the number of hours in one day) by $2\frac{1}{2}$ Miles (the Currents horary motion) the Product 60 is the number of Miles the Current fets in 24 hours. This 60 multiplyed by

4

4 (the number of days given) produceth 240 Miles for the Currents motion in 4 days; then ſay,

As the Ships ſimple motion BD 480—268124
Is to the Curr. ſimple motion BA 240—238021
So is Radius- ——— ——— -90.0-1000000

To tangent angle Reflex. BDA—26.33---969897

Hence the Ships Courſe is ESE 4°. 3″ Southward.

As ſine angle Reflexion BDA 26.33—992085
Is to Ships ſimple motion BD 480 Mil.-268124
So is Radius ——— 90.00 1000000

To Ships compound motion AD 576 Mil.-276039

PROB. 7. Fig. 44.

A Ship ſails in 8 hours from A ſome certain Cape towards B bearing South 18 Miles by Log. in a Current ſetting to the Eaſtward, and then obſerving the ſame Cape ſhe finds it to bear WNW. I demand how faſt the Current ſets, and the Ships true diſtance run.

Let A repreſent the Cape, BD the Ships drift to the Eaſtward: The Ship at D obſerves the Cape A to bear WNW, then in the Triangle ABD we have given AB 48 Miles, and the angle ADB 22°. 30′.

To find the motion of the Current BD.

As sine angle Reflex. ADB 22°. 30′ — 958283
Is to Ships simple motion AB 18 Miles — 125527
So is sine angle Deflex. BAD 67.30 — 996561

1122088

To Currents simple motion BD 43.6 Mil. — 163805

Hence it appears, that if the Currents simple motion be 43.6 Miles in 8 hours, the horary rate or drift thereof must be 5.45 Miles.

To find the Ships Compound motion AD.

As sine Angle Reflex. ADB 22°. 30′ — 958283
Is to Ships simple motion AB 18 Miles — 125527
So his Radius — 90.00 — 1000000

To the Ships comp. motion AD 47 Miles — 167244

PROB. 8. Fig. 45.

Admit AB.CD represent the sides of a River, let A represent one place on this side, and C another place on the farther side, let their distance be 96 Poles, Yards, *&c.* let the Course from A to C be NE $\frac{1}{2}$ E, and let the Current in this River drive directly East, $3\frac{1}{2}$ Miles every hour; then if a Boat row from A towards C after the rate of $5\frac{1}{2}$ Miles an hour; I demand upon what point of the Com-

Compaſs the Boat ſhall row, how faſt, and in what time to go directly over.

The ſides of the Triangle ACD are Suppoſitions: Therefore, firſt, ſet the Currents ſimple motion $3\frac{1}{2}$ Miles from C to D. From C with the Chord of 60°. ſtrike the arch EF, then becauſe SW$\frac{1}{2}$W (the oppoſite point to the Courſe given) is $11\frac{1}{2}$ points, or 129°. 23′, ſet 129°. 23′ from F to E, and draw the line CEA. Laſtly, with $5\frac{1}{2}$ Miles ſet one foot in D, and with the other croſs the line CA in A and draw DA. Laſtly, From A draw AB parallel to CD, ſo ſhall ACD be the angle of Deflexion, ADC the angle of Reflexion, and the angle CAD may be called the angle of Incidence. Alſo CD is the Currents ſimple motion, and AD the motion of the Boat.

1. To find the angle of Incidence CAD.

As the Boats ſimple motion AD	$5\frac{1}{2}$	074036
Is to the ſine of Reflex. ACD	129.23	988813
So is the Curr. ſimple mot. CD	$3\frac{1}{2}$	054406
		1043219
To the ſine of Incid. angle CAD	29.28	969183

Which added to $4\frac{1}{2}$ points, or 50°. 37′ makes 80°. 05′. Therefore the Courſe from A to D is EBN 1°. 20′ Eaſtward.

To

To find the Distance AD.

From the Quadrant IK 90°. 00', subtract the angle IAG 80°. 05' the remainer 09°. 55' is the angle GAK, which by 27. 1 *Euc.* is equal to the angle of Reflex. ADC.

As sine angle Reflexion ADC 9°. 55'—923607
Is to distance 96 Poles, *&c.* ————————198227
So is sine of ang. Deflex. ACD 129.23----988813

1187040

To Boats simple motion AD 431 Poles---263433

To find the time required.

Seeing that 320 Poles make a Mile, and the Boats horary motion is $5\frac{1}{2}$ Miles, therefore 320 multiplyed by 5.5. produceth 1760 for the number of Poles which the Boat runs every hour. Therefore

As the Boats simp. hor. motion 1760--324551
Is to 60' (the minutes in one hour) -177815
So is the simple motion before found 431--263433

441248

To the time required in minutes 14.7----116697

PROB. 9.

To find where there is a Current at Sea, which way it ſets, and how faſt.

This may moſt conveniently be done by comparing the reckoning outwards, with the reckoning homewards, after this manner.

Admit a Ship ſail from a certain Port (either upon one or upon ſeveral Rhumbs) till ſhe arrives at a ſecond, and there find by her dead reckoning that ſhe is more Southerly than the Port from whence ſhe departed by 432 Miles, and more Weſterly by 234 Miles. But by her dead reckoning homeward, when ſhe arrived at the firſt Port ſhe found ſhe was 432 Miles to the Northward of the ſecond, and to the Eaſtward thereof 345 Miles: Then let us ſuppoſe ſhe ſailed from the firſt Port to the ſecond in three days time, and from the ſecond to the firſt in 5 days, I demand which way the Current ſets and how faſt.

Becauſe the Eaſtward diſtance homewards did exceed the Weſtward diſtance outwards, ſubtract the one from the other, namely 234 from 345 the remainer 111 Miles, is the motion of the Current Weſtward.

Hence it appears, the Current ſets to the Weſtward 111 Miles in 8 days time, which is almoſt 14 Miles a day.

CHAP.

CHAP. XIV.

A Collection of ſundry choice Problems in Plain Sailing.

PROB. 1. Fig. 47.

THERE are two Ships under the ſame Meridian, the firſt in the N°. Latitude of 50°. 00′, the ſecond in an unknown N°. Latitude; when the firſt Ship had ſailed 88 Leagues between the South and Weſt, and the ſecond 56 Leagues between the North and Weſt; they both meet, their Courſe being 6 points aſunder, I demand each Ships Courſe, and in what Latitude they did meet.

GEOMETRICALLY.

Draw the line BA at pleaſure: Make the angle BAC 67°. 30′, ſet 88 Leagues from A to B, and 56 Leagues from A to C, draw the line BC, which ſhall repreſent the Meridian from whence both the Ships departed: From A draw AD perpend. to BC. ſo ſhall BD be the firſt Ships differ. Latit. DC the ſecond Ships differ. Latit. and AD ſhall be the departure, common to them both; alſo the angle ABD ſhall be the firſt Ships Courſe, and ACD the ſecond.

LOGA-

LOGARITHMICALLY.

As the ſum of the 2 ſides AB.AC	144	215836
Is to their diff. ————	32	150515
So t. ½ ſum ang. B and C- ——	56. 15	1017510
		1168025
To t. ½ their diff. 18°. 24′ ——	——	952189

Which added to the ½ Sum 56°. 15′ makes the greater of the two unknown angles, *viz.* ACD 74°. 39′, and ſubtracted from the ½ Sum, leaves the angle ABC 37°. 51′.

As Radius ſine angle ADB 90°. 00′—	1000000
Is to diſtance run AB 88 leagues ————	194448
So is ſine angle BAD 52°. 09′ —— ——	989741
To diff. Latitude BD 69.5 leagues ————	184189

Thus it appears the firſt Ships Courſe is SWBS 4°. 6′ W.

As Radius ſine angle ADC 90°. 00′—	1000000
Is to diſtance run AC 56 leagues-- ————	174818
So is ſine of the Courſe, ang.CAD 15°.21′-	942277
To ſecond Ships diff. latit. CD 14.8 leag.-	117095

Hence it appears by 1. and 2. Rule 1. Page 179. that the Ship is in the N°. Latitude of 46°. 32′. and that the ſecond Ships Courſe is WBN 4°. 6′ Northwards.

Note, The Triangles ADB, ADC are right angled at D, therefore if the angle ABD 37°. 51′

be known, ſubtract it from 90°. the remainer is the angle BAD 52°. 09′: Alſo ACD 74°. 39′ ſubtracted from 90°. 00′. the remainer is CAD 15°. 21′.

PROB. 2. Fig. 48.

A Ship ſails from the N°. Latit. of 53°. 00′ upon ſome Rhumb between the South and the Weſt, till her diff. latit. be 25 leagues, and her diſtance run and departure be together 84 leagues. I demand them ſeverally and the Courſe ſhe ſailed.

GEOMETRICALLY.

Draw the line AB, upon which ſet the diff. latit. from A to B, draw BC perpend. to AB, and ſet 84 leagues from B to C, then draw the line AC, which you muſt biſect by the line DE, then draw the line AD, which ſhall be equal to the line DC, ſo ſhall BD be the departure, and AD the required diſtance run.

LOGARITHMICALLY.

As the ſide AB 25 leagues	139794
Is to Radius ſine of 90^{s}. 00	1000000
So is the ſide BC 84 leagues	192427
To tangent angle BAC 73°. 26	1052633

Which ſubtracted from 90°. 00′, the remainer is the angle BCA 16°. 34′, but the angle BCA is equal to the angle CAD, becauſe the two ſides

AD

AD. DC are equal, therefore from the angle BAC 73°. 26′ ſubtract the angle DAC 16°. 34′. the remainer is the angle BAD 56°. 52′, or Ships Courſe from A to D, *viz.* SWBW 0°. 37′ W. which alſo ſubtracted from 90°. the remainer is the angle ADB, *viz.* 33°. 8′.

As ſine angle ADB 33°. 08′	973766
Is to diff. Latitude AB 25 leagues	139794
So is Radius ſine of 90°. 00′	1000000
To the diſtance required AD 45.75 leag.	166028

Which ſubtracted from 84, the remainer is 38. 25 leagues the departure required.

PROB. 3. Fig. 49.

A Ship ſails upon ſome Rhumb between the North and Eaſt, ſo that for every 86 Miles ſhe departs from her firſt Meridian 58 Miles, the latitude ſhe came from being 48°. 30′. I demand the Courſe and diſtance ſhe muſt ſail to come into the lat. of 50°.

GEOMETRICALLY.

Project the Triangle ABC, making BC 58 Miles and AC 86 Miles, then by 1. 3. Rule in Page 180. find the diff. latit. between 50°. 00′ and 48°. 30′, which is 1°. 30′ or 90 Miles. Set 90 Miles from A to D, draw DE parallel to BC, and continue the line AC to cut DE in E, ſo ſhall AE be the diſtance, and the angle DAE the Courſe required.

LOGARITHMICALLY.

As the distance run AC 86 Miles —— 193449
Is to Radius sine 90°. 00′- ———— -1000000
So is the departure BC 58 Miles— ——— 176342

To sine of the Course angle BAC 42°.25′--982893

Therefore the Course is NE 2°. 35′ Northward.
As sine of the angle DE A 47°.35′ —986820
Is to diff. latit. AD 90 Miles ——— — 195424
So is Radius sine of 90°.00′-——— —1000000

To the distance required AE 122 Miles-— 208604

PROB. 4. Fig. 50.

A Pilot sailing towards the East hath forgot his Course, yet thus much he knows, that if he had sailed upon his true Course 108 leagues, he should have raised the Pole 2°. 51′ and have been as much more distant from the Meridian than now he is, and also should have been 57 Minutes more Northerly, I demand the Course, distance and departure.

GEOMETRICALLY.

Finish the Triangle ABC, in which let the diff. latit. AB be 57 leagues, and the distance run AC 108 leagues: Then set 19 (the leagues in 57 min.) from B to D, draw DE parallel to BC. Bisect EC in F, and from F draw FE parallel to AB. Lastly

Laftly draw the line AE, fo fhall AD be the Ship diff. latit. DE the departure and AE the Ships diftance run required.

LOGARITHMICALLY.

As the diftance run AC 108 leagues—— 203342
Is to Radius fine of 90°. 00′- ——— —1000000
So is the diff. latit. AB 57 leagues .—— 175587

To fine of the angle ACD 31. 51.——— 972245

Which fubtracted from 90°. 00′. leaves the angle CAD 58°. 09′, therefore the Ships Courfe is NEBE 1°. 54′ Eaftward.

As Radius fine of 90°. 00 —- ———1000000
Is to diftance run AC 108 leagues-———203342
So is fine of the Courfe, angle DAC 58.09-992912

To the Ships departure BC 91.74 leagues-196254

The ½ of BC 91.74 is 45.87. equal to DE, then reduce 57 minutes into leagues, *viz.* 19. and fet 19 leagues from D to B, fo fhall AB be 38 leagues. Then in the triangle ABE fay,

As AB 38 leagues --——— ——— ---157978
Is to Radius —— —— — ---1000000
So is BC 45.87 leagues-- — —166152

To t. of the Courfe BAC 50°. 22′———1008174

As the sine angle BAC 50.22———————9888657
Is to departure BC 45.87 leagues-———————166152
So is Radius sine of 90.00 — — —1000000

To the distance required AC 60 leagues--177495

Therefore the Course from A to C is NE 50. 22′ Eastward.

PROB. 5. Fig. 51.

Two Ships, the one sailing between the South and East 94 leagues; the other between the South and West 68 leagues, their Courses being 5 points asunder; then if the Eastermost Ships diff. latitude be 36 leagues more than the Westermost Ships diff. latit. I demand each Ships Course, their bearing and distance asunder.

GEOMETRICALLY.

Draw the line BA. make the angle BAC 56°. 15′. set 68 leagues from A to B, and 94 leagues from A to C, and draw BC. With 36 Leaugues in your Compass, set one foot in C and strike the Arch E, and from B through the highest point in the Arch E, draw the line BE, which shall be an East or West line, also draw EC and AD perpend. to BE, so shall CE be a North, and AD a South line, the angle BAD shall be the Westermost Ships Course, and DAC the Eastermost: Lastly the angle ABC shall be the bearing, and BC the distance between the two Ships.

LO-

LOGARITHMICALLY.

As the Sum of the 2 ſides AB.AC 162--220951
Is to their difference 26 leagues —— ---141497
So is t. $\frac{1}{2}$ Sum ang. B and C 61°.52′ —— 1027189

1168686

To t. $\frac{1}{2}$ their diff. 16°. 42′— —— 947735

Which added to the $\frac{1}{2}$ Sum, makes the angle ABC 78°. 34′ and ſubtracted from it, leaves the angle ACB 45°. 10′.

As ſine of the angle ABC 78°. 34′------999129
Is to diſtance run AC 94 leagues ——— 197312
So is the ſine of the angle BAC 56° 15′--991984

1189296

To the diſtance BC 79.7 leagues ——— 190167

As the ſide BC 79. 7 leagues- ——— 190167
Is to Radius ſine angle BEC 90°. 00′—— 1000000
So is diff. latit. CE 36 leagues ——— --155630

To ſine angle CBE 26°. 50′- -965463
Therefore the Courſe from B to C is ESE 4°. 20′ S°.

But the angle CBE 26°. 50′ ſubtracted from the angle ABC 78°. 34′ leaves the angle ABD 51°. 44′. this ſubtracted from 90°. the remainer is BAD 38.16. Therefore the Courſe from A to B is SWBS 4°. 31′ W. Laſtly, ſubtract BAD 38. 16′ from BAC 56°. 15′, the remainer is ∠ AC 17°.

 59′,

59', and confequently the Eaftermoft Ships Courfe is SBE 6°. 44' Eaftward.

PROB. 6. Fig. 52.

There are three Ships of equal diftance from one Port, and bound for the fame place: The Eaftermoft is diftant from the middlemoft 96 leagues, and bears SEBE, the middlemoft is diftant from the Eaftermoft 80 leagues, and bears SW from her. I demand each Ships Courfe to the Port, and how far they are diftant from it.

GEOMETRICALLY.

Draw an obfcure line as BE to reprefent a South line: Draw the SW line B C, upon which fet 80 leagues from B to C: draw the SEBE line BA, upon which fet 96 leagues from B to A: Then draw CA, which fhews the bearing and diftance between the firft and third Ships.

Through the three points ABC ftrike a Circle, whofe Center D reprefents the Port required: Laftly, draw the Semidiameters DA. DB. DC. which fhall be the diftance of each Ship from the Port.

LOGA-

LOGARITHMICALLY.

As the Sum of the 2 ſides BA.BC 176 l.--224551
Is to their difference 16 leagues-- ——— 120412
So is t.½ Sum of the ang. BAC.BCA 39.22-991404

1111816

To t.½ their difference 4°. 16'-—————887265

Which added to the ½ Sum makes the angle BCA 43°. 38' and ſubtracted from it leaves the angle BAC 35°. 06'. Therefore the Courſe from C to A is EBN 9°. 53'E.

As ſine of the angle BCA 43°. 38'- — 983887
Is to the ſide AB 96 leagues—————198227
So is ſine angle ABC 101°. 15'——999157

1197384

To the ſide CA 136 leagues—— —— 213497

Which is the diſtance between the two Ships A and C.

By 20. 3. *Euc.* the angle ADC is double to the angle ABC, which is 101°. 15', therefore the angle ADC is 202°. 30', which ſubtracted from 360°. 00', the remainer is the angle CDA, *viz.* 157°. 30', but becauſe the ſides DA.DC are equal, therefore the angles DAC.DCA are equal. Therefore ſubtract 157°. 30' from 180°. 00', the remainer is 22°. 30' ½ whereof is the angle CAD 11°. 15', or ACD.

As

As ſine of the inter.ang.CDA 157°.30 — 958284
Is to the diſtance CA 136 leagues —— 213497
So is ſine angle DAC 11°. 15 ——— 929023

1142520

To the ſide DC 69.56 leagues ——— 184236
Which is the diſtance of each Ship from the Port.
To find the Courſe from C to D, the angle BCD is 43°. 38′ which added to 11°. 15′, the Sum is 54°. 57′ from the NE line Eaſtward, therefore the Courſe from C to D is ESE 1°. 22′ E.

PROB. 7. Fig. 53.

Two Ships ſail from two ſeveral Ports being both in one Parallel, and 90 leagues aſunder; the Weſtermoſt Ship ſails NEBE, the Eaſtermoſt Ship ſails upon ſome point between the North and Weſt, and then they meet: If the diſtance run of both theſe Ships be together 136 leagues, I demand them ſeverally and the Eaſtermoſt Ships Courſe.

GEOMETRICALLY.

Draw AB, ſet 136 leagues from A to B, make the angle ABC 33°. 45′, and ſet 90 leagues from B to C, then draw the line AC: Biſect the line AC in D by the line DE and draw CE, ſo ſhall AE.EC be equal to each other: Therefore BE.EC ſhall be equal to AB: alſo BE ſhall be the Weſtermoſt Ship's diſtance, the angle BCE the Eaſtermoſt Ships Courſe. Laſtly BC is the parallel they departed from.

LO-

LOGARITHMICALLY.

As the Sum of the two ſides AB.BC.226—235410
Is to their difference 46 leagues- ——— 166275
So is t. ½ Sum ang. BAC.BCA 73°. 07'-—1051783

1218058

To t. ½ their diff. 33°. 5' —— —— 982648

Which added to the ½ Sum 73°. 07' makes the angle ACB 106°. 58'. and ſubtracted from it leaves BAC 39°. 16'. But the angles EAC. ECA are equal, becauſe of the equal ſides AE.EC, therefore ſubtract ACE 39°. 16' from ACB 106°. 58', the remainer ECB is 67°. 42' Laſtly add the angles EBC 33°. 45', and ECB 67°. 42', together their Sum will be 101°. 27', which ſubtracted from 180°. 06, the remainer is the angle BEC 78°. 33'.

As ſine angle BEC 78°. 33' —— —— 999127
Is to the Parallel diſtance BC 90 leagues—195424
So is the ſine angle EBC 33.45- ——— 974473

1169897

To the diſtance required EC 51 leagues--170770

Which ſubtracted from 136 or AB, the remainer is BE 85 leagues for the Weſtermoſt Ships diſtance run, and the angle ECB is the Eaſtermoſt Ships Courſe, *viz.* NNW 0°. 12' N.

PROB.

PROB. 8. Fig. 54.

A Ship ſails between the South and Weſt till her diſtance run be 86 leagues more than her diff. Latit. and 54 leagues more than her departure, I demand her Courſe, diſtance run and departure.

GEOMETRICALLY.

Draw the line AD, ſet 86 leagues from A to B, and from B to C, and 54 leagues from C to D, upon C erect the perpend. CE. Biſect AD in O, from O ſtrike the Semicircle to cut the perpend. CE in E, ſo ſhall CE be an Auxiliary line. Then draw the line EH, ſet 86 leagues from E to F, and ſet CE from F to G, and from E ſtrike the arch GI. Alſo ſet 54 leagues from G to H, and from H ſtrike the arch FI. Laſtly draw the lines EI.HI, ſo ſhall EI be the departure, HI the diff. of Latit. and EH the Ships diſtance run.

ARITHMETICALLY.

Multiply 172 (the double of 86) by 54, out of the product 9288 extract the ſquare root, which here is 96, ſo ſhall this ſquare root be the length of the line CE: Therefore 86. 96. 54 added together, make EH the diſtance run 236: From which ſubtract 86, the remainer 150 is HI the diff. latitude, and 54 ſubtracted from 236, gives EI 182 for the departure. The Courſe may be found by Caſe 6. of plain ſailing.

PROB.

PROB. 9. Fig. 55.

Two Ships ſail from one place, the one ſails SBW, the other WSW, and arrive at two ſeveral Ports: The Weſtermoſt Port bears from the Eaſtermoſt NWBN, then if the diſtance run of both the Ships and diſtance between the two Ports be together 130 leagues, I demand them ſeverally.

GEOMETRICALLY.

Draw AB for a SBW, and AC for a SW line, and becauſe we have no ſide given in the triangle we will ſuppoſe the ſide AB to be 100 leagues: From B draw a NWBW line, ſo have you finiſhed the triangle ABC, having its angles equal to the angles given in the Queſtion, but its ſides are ſuppoſititious.

LOGARITHMICALLY.

As ſine angle ACB 101°. 15′	999157
Is to ſide AB 100 leagues	200000
So is ſine angle CAB 33. 45	974473
To the ſide BC 56.65 leagues	175316

As

As ſine angle ACB 101°. 15'- ——— 99915
Is to ſide AB 100 leagues ——— ——— 200000
So is ſine angle ABC 45°. 06— ——— 984948

To the ſide AC 72.01 leagues——— — 185791

The Sum of theſe three ſides AB. BC. AC is 228.66 leagues, which exceeds 130, therefore ſay by

Natural Arithmetick.

AB
If 228.66—130—100
100

228.66 | 13000.0000 | 56.85 AB.
114330

156700
37196

195040
182928

121120
114330

6790

If 228.66 -- 130---56.65

130

169950

5665

228.66 | 7364.50.00 | 32.20 BC

685988

50470

45732

47380

45732

16480

If 228.66 —— 130 —— 72.01

130

216030

7201

AC.

228.66 | 9361.300 | 40.94 ferè.

91464

214900

205794

91060

P R O O F.

56.85

32.20

40.94

Sum ——— 129.99

Mr.

Mr. *Richard Norwood* in his Doctrine of Triangles, *Page* 135, has laid down certain Problems, which being of uſe to our Seamen, I thought fit to inſert in this place.

A Ship ſailing to windward, will uſually lie within $5\frac{1}{2}$, or 6 points of the Wind, yet by reaſon of her Lee-ward way ſhe will ſcarce make her way good within $6\frac{1}{2}$ points of the Wind, ſometimes more, ſometimes leſs, according as the Sea is rougher or ſmoother, and according to the Mould of the Ship, and ſail ſhe bears: So that in ſailing to a place directly to Windward, ſhe ſails uſually three or four times the diſtance of that place before ſhe arrives at it. But if the place to which ſhe ſails be not directly to Windward, but within a Point, two, three, four, five or ſix points of the Wind, then tho' ſhe turn to Windward, as before, yet ſhe will ſooner arrive at the place than before: But how, and in what proportion, for the one, and for the other may appear by theſe enſuing Problems.

PROB. 10. Fig. 56.

Let the poſition from A to B be South 86 miles and the Wind at South Then ſuppoſe the Ship intending to ſail from A to B, make her way good within 73°. of the Wind, which is almoſt $6\frac{1}{2}$ points, I demand how far ſhe muſt ſail upon one Tack, and how far upon the other Tack, to arrive at B.

In this Figure AC is the Ships way, ſo near the Wind as ſhe can lie, the angle BAC is 73°. and the angle ABC is equal to it: The Sum of theſe two

two angles A and B is 146°. 06 which ſubtracted from 180°. the remainer is the angle ACB 34°. 06. Therefore ſay,

As ſine angle at C 34°. 06	974756
Is to the ſide AB 86 Miles	193449
So is ſine of the angle at A 73°. 00	998059
	1191508
To the ſide BC 147 Miles	216752

But the ſide FC is equal to the ſide AC. Therefore the Ship muſt ſail 147 Miles with her Larbord Tack aboard, and as much with her Starboard Tack on board.

PROB. 11. Fig. 57.

Admit the diſtance from A to E be 96 Miles SW. the Wind at South, and let the Ship make her way good within 70°. of the Wind: I demand the diſtances AC, and CE, that is the Ships way by dead reckoning upon the one Tack, and upon the other.

Here AB repreſents a South line, or point upon which the Wind blows, the angle BAC is 70°. 06. from which ſubtract the angle BAE 4 points, or 45°. the remainer 25°. 06 is the angle EAC. Alſo the compt. of 70°. is 20°. which doubled is 40°. for the angle at C. and by adding theſe two angles, namely EAC 25°. 06 and ACE 40°. the Sum 65°. 06 is the angle AEB by 32. 1 *Euc.* Then in the triangle AEC we have given the ſide AE 96 Miles, the angles C 40°. and AEC 115°. 06

S (the

(the compt. of AEB to 180°. 00.) to find the side AC.CE. Therefore say,

As sine angle ACE 40°. 00	980800
Is to side AE 96 Miles	19822
So is sine angle AEC 115°. 00	99572
	119395
To the side AC 135. 3 Miles	213148
As sine angle ACE 40°. 00	980800
Is to side the AE 96 Miles	19822
So is sine angle EAC 25°. 00	96259
To the side EC 63 Miles	116082
	18001

Thus it appears, that to sail from A to E which is SW 96 Miles with the Wind at South, and to make her way good within 70°. 00 of the Wind, the Ship must sail with her Larboard Tack aboard 135. 3 Miles, and with her Starboard Tack on board 63 Miles: Her Course from A to C being WSW 2°. 36 W. and from C to E her Course is EBS 8°. 45′ Southward, or ESE 2°. 36 Eastward.

If you desire more Questions of this nature, see *Norwood*'s Doctrine of Triangles, *Page* 137. I shall not enlarge upon them, because as they are capable of sundry improvements which he hath omitted, so I shall refer their further Explication to a more convenient time.

CHAP.

f Navigation.

30°. 06.) to find

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06 —

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cô —

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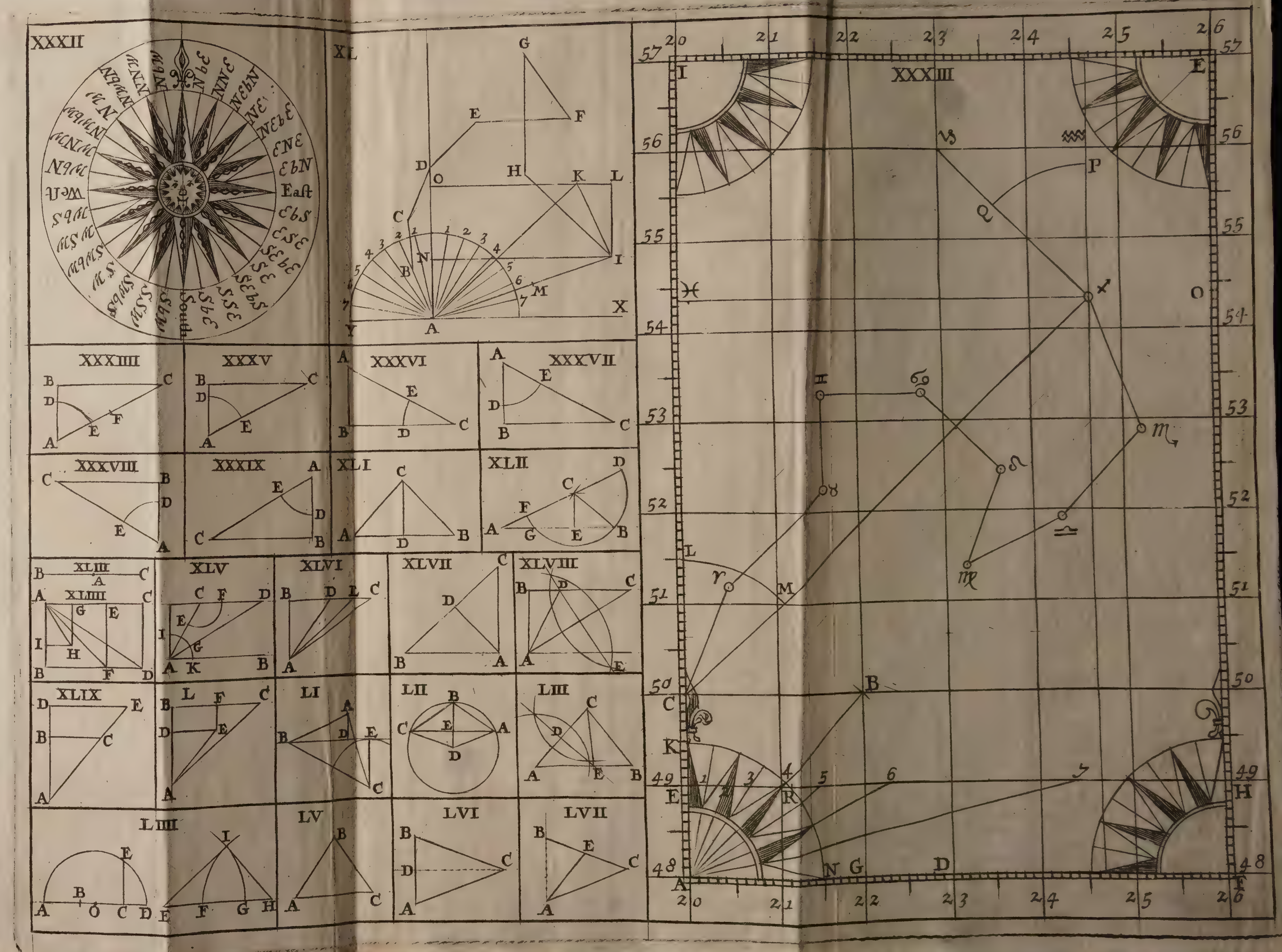


CHAP. XV.

Of Sailing by the true Sea Chart, commonly called Mercator's *Chart.*

THE way of Sailing by the true Sea Chart, teacheth us a Geographical Method for drawing the Meridians and Parallels of latitude (which upon the Globe are Circles) by right lines.

FIG. 60.

To make a true Sea Chart between any two latitudes, containing any quantity of longitude: Let it be required to make a true Sea Chart, beginning at the latitude of 48°. 06, and ending at the latitude of 54°. 06, containing 8°. of longitude.

Draw the line AB, which divide into 8 equal parts, so shall each of these contain one degree; upon each of these equal parts or degrees of longitude, erect Perpendiculars, as in the Figure, so shall these Perpendiculars represent the Meridians of this Chart. Then because each degree is commonly divided into 60 equal parts (which I call Sexagenary Miles) therefore divide each degree

into 10 equal parts, so shall each of these small Divisions represent 6 Sexagenary Miles.

Then to graduate the Meridians, find the Meridional parts for the latit. 48°. and 49°. which by the following Table are 3297. and 3381. their diff. is 90 meridional Miles, or 1°. 30. which take from the line A^{D}, and set from 48°. to 49°. then draw the Parallel of 49°. also find the meridional Miles answering to the latit. 49°. and 50°. the diff. between the two responding numbers will be 93, or 1°. 33', which apply from 49°. to 50°. and draw the Parallel of 50°. and thus you may proceed with all the rest.

Of the use of this Chart.

Draw the line EF, which must be a line of equal parts, or degrees, marked with the same numbers as is the Meridian of the Chart. Each degree in this line must be equal to two degrees in the line A^{D}, and also divided into 10 equal parts. This line so divided, I call the Auxiliary line, whose use I shall explain in these following Cases.

CASE 1. Fig. 60.

Course and distance run given, to find the Ships Latitude and Longitude.

A Ship from the North latit. 48°. 06 and East longitude of 20°. 06. sails NEbN 84 miles. I demand her latitude and longitude.

By

By the Chart.

1. From A draw the NEBN line AF, and from the Auxiliary line EF take 1°. 24', or 84 miles, which set from A to F.

2. From F draw FG parallel to AB, and set AG upon the Auxiliary line from A to H, so shall the point H shew the Ship is in the North latit. 49°. 10.

3. In the Meridian line of the Chart AC find the latitude of 49°. 10' which is at K, from K draw KL parallel to AB, so shall AK be the Ships diff. latitude enlarged, *viz.* 105 miles, or 1°.45'. KL the diff. longitude 71 miles, or 1°. 11'. So that by the Chart the Ship is in the North latit. of 49°. 10', and East longitude of 21°. 11. *viz.* at the point L.

There are three several ways in use amongst Seamen for solving Questions of this nature, both Arithmetically and Geometrically, which here not for necessity (for I look upon them all to be unnecessary Follies) but to gratifie all well-wishers to this kind of Learning, I have here inserted them, with some short Notes relating to them.

NOTE 1.

The first way is done by taking the half of the latit. you came from, and the ½ of that latit. you are come into, to both these, add 45°. 00 and seek for the tangents of their two Sums. Subtract the tangent of the lesser arch, from the tangent of the

greater arch, the remainer divided by 126.3, the Quotient ſhall be the meridional miles in the diff. latit. enlarged.

Thus the ½ of 48°. 06 is 24°. 06, to which add 45°. the Sum is 69°. 06, whoſe tangent is 104158226.

Again, the ½ of 49°. 16 is 24°. 35′, to which add 45°. 06, the Sum is 69°. 35′, whoſe tangent is 104291912, the leſſer of theſe tangents ſubtracted from the greater, the remainer is 133686, which divided by 1263, the Quotient is 105 for the miles in the enlarged diff. latitude.

The reaſon whereof is this, If there be a Meridian line, and a line of artificial tangents, both graduated from the ſame line of equal parts, a degree upon this artificial tangent line ſhall be double to a degree upon this Meridian line, and conſequently a minute upon the one, ſhall be double to a minute upon the other. And thus we find the artificial tangent of one minute (omitting the other preceding figures) to be 2527, which by the foregoing reaſon is equal to two minutes upon the Meridian line. Therefore the ½ of this number, *viz.* 1263, will be equal to one minute upon the Meridian line, therefore 133686 (the difference between the two foregoing tangents) divided by 1263, gives the meridional miles required, which exactly anſwer to the Table of Meridional parts.

GEOMETRICALLY. Fig. 71.

By the first Case in plain sailing project the triangle ABC, so shall the angle BAC be the Course, AC the distance run, AB the diff. latit. and BC the departure.

By Case 1. of plain sailing, the diff. latit. will be 70 miles, therefore by 1. Rule 1. the Ship is in the North latit. of 49°. 10, which being known, you must (by the preceding Rule) find the diff. latit. enlarged, *viz.* 105 miles, which apply from A to D, and draw DE parallel to BC, so shall AE be the diff. longitude required.

ARITHMETICALLY.

As Radius sine of 90°. 00	1000000
Is to diff. latitude enlarged 105 miles	982489
So is tangent angle BAC 33°. 45′	202118
To diff. longitude DE 70 miles	184607

NOTE 2. Fig. 72.

The second way is by the middle latitude, which depends upon this Theorem.

As the Co-sine of the middle latitude
Is to the Tangent of the Course.
So is the difference of latitude in miles or leagues
To the difference of longitude in miles or leagues.

But this Theorem wants demonstration, and is only to be admitted in short distances, and particularly in latitudes less than 60 degrees. But the

contrivance (whoever was the Author of it) is not altogether contemptible, becaufe it is Geometrically fo difpofed, that you are to find two like triangles; in the former of which we muft always have two parts given, *viz.* the Co-fine of the middle latitude, and tangent of the Courfe; and in the other we muft always have given either the diff. latit. or diff. longit. to find the refponding proportional part.

To find the middle latitude, you muft always add the latitude you came from, to the latitude you are come to; ½ that Sum fhall be the middle latitude.

GEOMETRICALLY.

1. From C ftrike the circle DAE, draw the diameters DE. AK at right angles to each other.

2. From A (with the diftance AC) ftrike the arch CB, fet the angle of the Courfe from C to B, and draw the line ABL to cut the diameter DE in O. Set the diftance run from A to L, and draw LK parallel to DE, fo fhall AL be the diftance run, AK the diff. latitude, and KL the departure.

3. By 1. Rule 1. Chap.12. find the Ships latit. *viz.* 49°. 16, which added to the latitude 48°.06, makes 97°. 16 the ½ whereof, *viz.* 48°. 35' is the middle latitude.

4. From the line of Chords take 48°. 35', and fet the fame from D to F and G, and draw the line FG to cut DE in H.

5. Set

5. Set CH from C to I, a ruler on I and O will give the line ION. Laſtly, make IM equal to AK, and draw MN parallel to DE, ſo ſhall MN be the diff. longitude required.

LOGARITHMICALLY.

As Co-ſine middle latit. HF.	48°. 35′	982054
Is to tangent of the Courſe CO	33. 45	982489
So is the diff. latitude IM	70 miles	184500
		1166989
To the diff. longitude MN	71 miles	184935

NOTE 3. Fig. 73.

This third way (which really depends upon that of middle latitude) ſhews us how to find the latitude enlarged Geometrically, thus.

1. By *Caſe* 1. of Plain Sailing, finiſh the triangle ABC, in which AB is the true diff. latitude, AC the diſtance run, and BC the departure.

2. By *Note* 2. find the middle latitude, which ſet from D to F, and draw FG perpendicular to AB.

3. From A with the diſtance AG, ſtrike the arch GI; biſect the diff. latit. AB in H, and ſet AH from G to I, then draw the line AIK.

4. Set DK from A to L, and from L to M, draw MN parallel to BC, ſo ſhall AM be the diff. latitude enlarged, and MN the diff. longitude required.

LOGA-

LOGARITHMICALLY.

Find the diff. latit. in Meridional parts between the latit. the Ship came from, and the latit. ſhe is come into, which is 105 miles.

As Radius ſine of 90°.00 ——— 1000000
Is to diff. latit. enlarged AM 105 miles — 202118
So is t. Courſe, angl. MAN 33.45 ——— 982489

To diff. longit. MN 71 miles ——— 184607

CASE 2.

Both Latitudes, and both Longitudes given, to find the Courſe and Diſtance.

A Ship from the North latit. of 48°. 06, and Eaſt longitude of 20°. 06, is bound for a Port in the North latit. of 49°. 16, and Eaſt longit. of 21°. 11′. I demand her Courſe and diſtance.

By the Chart. Fig. 60.

1. It is evident from the Chart, that the firſt place lies at A, the ſecond at L. Draw a line from A to L; ſo ſhall it appear, that the Courſe from A to L is NEBN.

2. By the Chart it appears, that the line KL lies in the North latit. of 49°. 16. Therefore ſeek for the latit. of 49°. 16 in the Auxiliary line EF, which you will find at H.

3. From

3. From H draw GF parallel to AB, to cut the line AL continued in F, apply AF upon the auxiliary line from E to I, so shall EI 1°. 24′ be the distance required.

By the Artificial Tangents.

Take the ½ of each latitude, and to it add 45°. then find the tangents of these two Sums. Subtract the tangent of the lesser, from the tangent of the greater, the remainer will be 133686; this divided by 1267, the Quotient 105 is the diff. latit. enlarged.

FIG. 71.

Set the diff. latit. enlarged, *viz.* 105 miles from A to D: Draw DE perpendic. to AD, and by 1. *Rule* 10. *Chap.* 12. find the diff. longit. *viz.* 71 miles, which apply from D to E. Draw the line AE, then in the triangle ADE find the angle DAE, thus.

As diff. latit. enlarged AD 105- ——— 202118
Is to Radius line- ——— 90°. 00- —— -1000000
So is diff. longit. DE 71 miles——— —— 184607

To tangent angle DAE 33°. 45′———— 982489

Also by 1. *Rule* 3. find the true differ. latitude between these two places, *viz.* 1°. 10, or 70 miles, which set from A to B, and draw BC parallel to DE, so shall AC be the distance required.

As ſine angle ACB 56°. 15′ ——— 991984
Is to true diff. latit. AB 70 miles- ——— 184500
So is Radius ſine of 90. 00 ——— 1000000

To the diſtance run 84 miles ——— 192516

By middle Latitude. Fig. 72.

1. Strike the circle, and croſs it with two diameters D .AK, at right angles to each other through the center C.

2. Set the diff. latit. given, from A to K, and draw KL perpend. to AK.

3. By *Note* 2. of this Chap. find the middle latitude, which ſet from D, to F and G; draw FG to cut DE in H; ſet CH from C to I, and AK from I to M: Draw MN parallel to DE, and ſet the diff. longit. given from M to N, and draw the line IN to cut DE in O.

4. Lay a Ruler upon A and O, and draw AQL to cut KL in L, ſo ſhall AL be the diſtance required, and KAL the angle of the Courſe.

LOGARITHMICALLY.

As the true diff. latit. IM 70 miles ——— 184500
Is to true diff. longit. MN 71 miles- ——— 184935
So is Co-ſine middle latit. CI 48°. 35′ ——— 982054

To tangent Courſe CO 33°. 45′ ——— 1166984

982489

Then

Then in the right angled plain triangle AKL, we have given the diff. latit. AK, and the angle KAL to find the distance AL, say,

As sine angle KLA 56°. 15′———— 991984
Is to diff. latitude AK 70 miles———— 184500
So is Radius sine of 90.00 ——————1000000

To the distance required AL 84 miles—192516

By difference of Latitude enlarged Geometrically.

FIG. 73.

1. Draw AM, set the diff. latit. in miles from A to B, draw BC perpen. to AM.

2. Find the middle latit. by *Note* 2. of this Chap. and from A strike the arch DK, upon which set the middle latit. from D to F.

3. Draw FG perpendic. to AB, and strike the arch GI.

4. Bisect AB in H, and set AH from G to I, draw the line AIK, and set DK from A to L, and from L to M, then draw MN parallel to BC, and set the diff. longit. from M to N.

5. Lastly draw AN to cut BC in C, so shall AC be the distance required.

By these two Propositions all the rest may easily be solved, *viz.*

If there be given two Latitudes, and the Course, the distance and diff. longitude may be found.

If one latitude, Course and departure, the other latitude, distance and diff. longitude may be found

If

If two latitudes and the diſtance be given, the Courſe and diff. longit. may be found.

If the departure and diſtance, with one of the latitudes be given, the other latitude, Courſe and diff. longitude may be found; for all theſe Caſes depend upon the foregoing Rules, which being very eaſie, and not worth the trouble of inſerting, I leave to the practice of my Reader, and proceed to

CASE 3. Fig. 60.

By one Latitude and diſtance run upon an Eaſt and Weſt Courſe to find the difference of Longitude.

A Ship in the North latit. of 50°. 36 ſails Eaſt 86 miles: I demand her diff. longitude.

By the Chart.

From the Parallel of 50°. 36 draw the line OP, then add ½ the miles in the diſtance run to the latit. given, it makes 51°. 13', which in the Meridian line falls at M; alſo from the given latit. ſubtract ½ the miles in the diſtance given, and there will remain 49°. 47', which in the ſame Meridian line will fall at N, apply the diſtance MN from O to P, ſo ſhall OP be the difference of longitude required.

By

By Projection. Fig. 74.

1. Draw the line AB, upon which set the distance given from A to B, from A strike the arch DE.

2. Set the given latit. from D to E, and draw the line AE at length.

3. Upon B, erect the perpend. BC to cut the line AE continued in C, so shall AC be the diff. longitude required.

LOGARITHMICALLY. Fig. 74.

Subtract the latit. given from 90°. 00, the remainer is the angle ACB.

As sine angle ACB 39°. 30 ——— 980351
Is to distance run AB 86 miles ——— 193449
So is Radius sine of 90°. 00 ——— 1000000

To the diff. longit. AC 135 miles ——— 213098

CASE 2. Fig. 60.

One Latitude and difference of Longitude given, to find the distance run East or West.

A Ship in the North latitude of 50°. 30. sails East till her diff. longit. be 135 miles. I demand her distance run.

By the Chart.

From the latitude given, draw the line OP, and from the line AB take 2°. 35′ equal to 135 miles, and ſet the ſame from O to P. Biſect OP in Q, and ſet OQ from O to M and N upon the Meridian line, ſo ſhall the degrees and minutes, contained between the points M and N, *viz.* 1°.26′ (equal to 86 miles) be the diſtance required.

By Projection. Fig. 74.

Draw AB, from A ſtrike the arch DE, upon which ſet the latit. 50°. 36 from D to E, draw the line AE at length, and ſet the diff. longit. from A to C. Biſect AC in F, and from F (with the diſtance AF) croſs AB in B, draw BC, ſo ſhall AB be the diſtance.

LOGARITHMICALLY. Fig. 74.

As Radius ſine of 90°. 06 ——— ———	1000000
Is to diff. longitude AC 135 miles- ———	213098
So is ſine angle ACB 39°. 36 ——— ———	980351
To diſtance required AB 86 miles ———	193449

CASE

CASE 5.

Distance run East or West and difference of Longitude given, to find the Latitude sailed in.

A Ship in an unknown Latitude sails 86 miles East, till her difference of Longitude be 135 miles. I demand the Latitude she sailed in.

By the Chart. Fig. 60.

From the line AB take 2°. 15′ (equal to 135 miles) or rather the $\frac{1}{2}$ thereof, *viz.* 1°. 7′$\frac{1}{2}$: also find $\frac{1}{2}$ the distance run, *viz.* 43 miles, and apply 1°. 7′$\frac{1}{2}$ (taken from the line AB) so, that it may contain 43 minutes upwards and downwards in the Meridian line, which it will not do till you come to the point O, and there 1°. 7′$\frac{1}{2}$ will reach from O to M, which is 43 minutes, and from O to N 43′. Therefore O is the point of latit. you have sailed in, which by the Chart appears to be 50°. 36.

By Projection. Fig. 74.

1. Draw the line AB, and set the distance run 86 miles from A to B, then upon B erect the perpendicular BC.
2. Take 135 miles in your Compasses, and with one foot in A, cross the perpend. BC in C.
3. Draw the line AC which shall be the difference of longitude.

Laſtly, From A with the Chord of 60°. 06 ſtrike the arch DE, which meaſured upon the ſame line of Chords gives 50°. 36 for the latitude in which the Ship has ſailed.

LOGARITHMICALLY.

As the diff longit. AC 135 miles	213098
Is to Radius ſine of 90°. 00′	1000000
So is diſtance run AB 84 miles	193449
To ſine angle ACB 39°. 36	980351

Which ſubtracted from 90°. 00′, the remainer is 50°. 36 the latitude required.

Some Problems ſolved by the True Sea Chart.

PROB. I. Fig. 74.

Two Ships under the Equinoctial are 128 miles aſunder, they both ſail North to the latit. of 60°. 06. I demand their diſtance in that Parallel.

This is no more than a different way of expreſſing that Problem mentioned in *Caſe* 4. of this Chap. for here we have diff longitude AC 128 miles, and the latitude (angle CAB) 60°. 06. to find the diſtance AB. therefore ſay,

As

As Radius sine of 90°. 00′	1000000
Is to diff. longitude 128 miles	210721
So is sine angle ACB 30°. 00′	969897
To distance required AB 64 miles	180618

Thus it appears, that tho' the Ships were 128 miles asunder under the Equinoctial (which is their diff. longitude) yet if they both sail North, or both continue under their first Meridians till they arrive at the Latitude of 60°. 00′. their diff. distance shall be only 64 miles asunder, by reason of the inclinations of the Meridians towards the Poles of the World.

PROB. 2. Fig. 74.

A Ship sails East in an unknown Latitude till she finds that 40 leagues under the Equinoctial, are equal to 64 leagues of that Parallel in which she sails; I demand the latitude of that Parallel.

This Problem is only a different way of expressing that in Case 5. of this *Chap.* Therefore set 40 leagues from A to B; draw BC perpendicular to AB, and from A (with 64 leagues in your Compasses) cross the perpendicular BC in C, and draw the line AC. Lastly, From A (with the Chord of 60°.) strike the arch DE, which being measured upon the same line of Chords, gives 51°. 19′ for the Latitude in which the Ship sailed.

LOGARITHMICALLY.

As diff. longitude AC 64 leagues	180618
Is to Radius ſine of 90°. 00′	1000000
So is diſtance AB 40 leagues	160206
To ſine angle ACB 38°. 41′	979588

Which ſubtracted from 90. 00 the remainer is 51°. 19′. the Latitude required.

Several other varieties there are of this nature, which I forbear to mention; becauſe I would not ſwell this Manual farther than I deſigned it.

To work a Traverſe by the True Sea Chart.

A Ship from the North latitude of 51°. 00′, and Eaſt longitude of 20°. 00′, ſails NNE 45 miles, NE 50 miles, ENE 58 miles, and Eaſt 36 miles. I demand her Latitude, Longitude, Courſe and diſtance run upon a ſtreight line, by the true Sea Chart.

From R, draw the NNE line RS, and by *Caſe* 1. of this *Chap.* find the Ships latitude R 1. and her longitude 1 S. upon that Courſe and Diſtance givin, ſo ſhall the latitude be 51°. 42′, and her longitude 20°. 29′.

From S draw the NE line ST, and find the Ships true point at T, ſo ſhall 2 T lie in the Latitude 52°. 17′, and longitude of 21°. 26′.

From

From T draw the ENE line TV, and find the Ships true point at V, so shall 3 V lie in the latit. of 52°. 39′, and longitude of 22°. 51′.

Lastly, From V draw VW parallel to AB, and by *Case* 3. of this *Chap.* set the Ships diff. longitude from V to W, then draw the line RW.

Thus from the Chart it appears, that the Ship is come into the North latit. of 52°. 39′, and East longit. of 23°. 50′.

Then to measure the distance RW, you must bisect the Ships difference of latit. 3 R in X, and her distance RW in Y, apply RY from X upwards upon the Meridian line AC, and it will reach to Y a point in the Latitude of 53°. 14′ and applyed downwards upon the same line, it will reach to Z, a point in the latitude of 50°. 24′, the difference between these two Numbers is 2°. 53′, or 173 miles for the Ships distance run.

Or thus.

Find the Latitude 52°. 39′ upon the Auxiliary line, and upon the same line take the distance between the latitude the Ship came from, *viz.* 51°. 00′ and 52°- 39′, apply the same from R (upon the Meridian line) to ♉, draw ♉ ♊ parallel to AB, and continue it to cut RW in ♊, so shall R ♊ (measured upon the Auxiliary line EF) contain 2°. 55′ or 175 miles as afore.

The Course may be measured as in the Cases of plain Sailing.

Having proceeded thus far, I ſhall ſhew you how to perform the ſame Arithmetically without the help of a Chart.

A Journal of my Voyage intended by God's Permiſſion in the *Lyon of London*, Capt. *A. B.* Commander from a Port in the North Latit. of 51°. 00′, and Eaſt longitude of 20°. 00′, to a Port in the North latitude of 52°. 39′, and Eaſt longitude of 23°. 50′, ſetting Sail *Decemb.* 8th 1694.

	Days of the Month.	Courſes Sailed.	Diſtance in Miles.	Miles Northing.	Miles Southing.	Miles Eaſting.	Miles Weſting.	Differ. Latitude reduced into Deg. and Min.		Latitude North or South	Diff. Longitude reduced into Degr. and Minutes.		Longitude Eaſt or Weſt.
								D.	M.		D.	M.	
								51	00	N	20	00	E
Dc.	8	NNE	45	42		29		0	42		0	29	
								51	42	N	20	29	E
	9	NE	50	35		57		0	35		0	57	
								52	17	N	21	26	E
	10	ENE	58	22		85		0	22		1	25	
								52	39	N	22	51	E
	11	Eaſt	36			59		00	00		0	59	
								52	39	N	23	50	E.

EXPLA-

EXPLANATION.

1. By the Calendar find NNE 45 miles, against which ſtands 42 miles for the Ships difference of latitude, which place under the Miles Northing; then by 1. *Rule* 1. *Chap.* 12. the Ships latitude is 51°. 42′ North.

2. Find the Meridional parts for 51°. 00′, *viz.* 3569, and alſo for 51°. 42′, *viz.* 3636, the difference is 67 miles for the difference of latitude enlarged, which alſo place under the miles Northing, below the true difference of latitude. Then ſay,

As Radius ſine of 90°. 00′	1000000
Is to diff. latit. enlarged 67 miles	182607
So is tangent angle Courſe 22°. 30′	961722
To diff. longitude 29 miles	144329

Then becauſe the Courſe is NNE place this diff. longitude 29 miles under the miles Eaſting; then by 1. *Rule* 8. the Ship is in the Eaſt longitude of 20°. 29′.

And thus you muſt proceed with all the other Courſes, except the Eaſt Courſe, which is thus to be effected, *viz.* by *Caſe* 3. of this *Chap.*

As Co-ſine Ships latitude 52°. 39′	978296
Is to diſtance run 36 miles	155630
So is Radius 90°. 00′	1000000
To the diff. longitude 59 Miles	177334

To find the Ships Courſe, you muſt add together all the ſeveral differences of latitude enlarged, *viz.* 67. 57. 36. the Sum whereof is 160. Alſo add together the ſeveral differences of Longitude, *viz.* 29. 57. 85. 59. the Sum whereof is 230. Then ſay,

As Sum of the diff. latit. enlarged 160—2204120
Is to Radius ſine angle 90°. 00′———— 10000000
So is Sum diff. longitude 230. ———— 2361728

To tangent of the Courſe 55°. 11′-——10157608

Therefore by *Rule* 12. *Chap.* 12. the Courſe is NEBE 1°. 4′ Northerly. To find the diſtance run upon a ſtreight line, add together all the true differences of latitude, *viz.* 42. 35. 22. the Sum is 99. Then ſay,

As Co-ſine of the Courſe 55°. 11′—— 9756599
Is to Sum true diff. of latitude 99 miles 1995635
So is Radius ſine of————90. 00′ — 10000000

To diſtance run required —— 173 miles—2239040

CHAP.

CHAP. XV.

To keep a Reckoning at Sea by the True Sea Chart.

WE have but few Books extant upon this uſeful Subject of *Navigation*, where the method of keeping a true Account of the Ships way, either by the Plain, or (as it is commonly call'd) *Mercator's* Chart is omitted; but whether or no theſe Books do ſufficiently inſtruct us in this particular, I leave to the Judgment of my Reader.

And for your aſſiſtance in this uſeful piece of skill, take notice of theſe following Particulars.

1. It is taken for granted amongſt our Seamen that the diſtance between knot and knot in the Log-line, muſt be 7 Fathom, or 42 Foot. This diſtance they mark out by meaſuring ſeven times the outmoſt extenſion of their Arms upon the Log-line: But ſeeing all Men cannot extend their Arms to one and the ſame ſtretch, the diſtance between the knots of the Log-line, muſt neceſſarily be either more or leſs than ſeven fathom, or 42 foot, whereas they ought to uſe all poſſible diligence in the diviſion of their line, the neglect whereof

whereof does many times occaſion great Errours in their Accounts.

2. They ought to examine the quantity of their Glaſſes, *viz.* whether they be more or leſs than 30 Seconds, or ½ a Minute, which may be eaſily done by the Rules in *Chap.* 4. For they uſually reckon that if the Ship runs away from the Log, the diſtance of one knot in the time of one Glaſs (let the Glaſs be more or leſs than ½ a Minute) ſhe muſt run a mile each hour. But by my Log-Tables, *Chap.* 4. it appears that if the Glaſs be 23 Seconds (the Log-line being always marked at 42 foot) the Ship runs $1\frac{74}{1000}$ mile each hour, that is, one mile and 74 thouſand parts of a mile: If the Glaſs be 24 Seconds, ſhe runs 1.029 miles each hour: If the Glaſs be 25 Seconds, ſhe runs .0987 miles each hour, that is 987 thouſand parts of a mile: And if the Glaſs be 30 Seconds, ſhe runs but 823 thouſand parts of a Mile each hour.

3. The common Inſtruments uſed at Sea for finding the Ships true latitude, are croſs Staves and Quadrants; in the uſe whereof they plainly ſee they take their Solar Meridian Altitudes by the upper Limb of the Sun, and yet never allow for the Suns Semidiameter, which is 16 minutes, which ought always to be ſubtracted from the Suns Meridian Altitude, otherwiſe they make it always 16 minutes more than really it is. This Errour added to the Eccentricity of the Eye (as Mr. *Wright* well obſerves) makes the Suns Meridian Altitude always erroneous.

4. The variation of the Compaſs is too much neglected, which ought to be enquired into almoſt continually: For by the Courſe corrected, and

and difference of latit. by Obſervation, (which is all the aid we can expect at Sea) the Ships true difference of longitude may in ſome meaſure be attained.

And now ſuppoſing the Young Seaman to be Induſtrious in obſerving theſe four Particulars, I ſhall proceed to direct him in the beſt method I can think of for keeping a Reckoning at Sea.

The firſt thing required in order to keep a true account of the Ships way, is the variation of the Compaſs, which moſt Authors tell you is to be diſcovered by the Suns Oriental or Occidental Amplitude; but the Amplitude cannot be found at Sea, unleſs the Latitude and Suns Declination be given, or elſe the Declination and difference of Aſcenſion be given: And the Latitude cannot be found without the Suns Amplitude, or difference of Aſcenſion: Therefore ſeeing theſe Analagous terms are reciprocal, the one cannot be given without the other, and conſequently (for this purpoſe) neither can be given.

The ſame folly attends the obſervation of the Suns Azimuth, taken by the Azimuth Compaſs: For the Suns true Amplitude, or Azimuth found at Sea is altogether precarious, and conſequently uſeleſs; the beſt way for finding either of them with certainty, is by the Rules in *Page* 158. and when the Compaſs is thus rectified, the Ships true Courſe is known; by help whereof, and the Ships difference of Latit. by obſervation we may by the ſecond Caſe of Plain Sailing find the true Depar-

Departure, which by *Case* 3. of Sailing by the true Sea Chart, may be turned into difference of Longitude.

That the way of keeping an exact Reckoning at Sea, may be better apprehended, I shall give you the form of the Log-Book and Journal both together, which is as followeth.

The Form of the Log-Book and Journal, from a Place in the N°. *Latit. of* 50°. 06, *and Longit.* 00°. 06. *setting Sail* June 24. 1694. *Supposing the distance of each Knot upon the Log-line to be* 42 *Feet, and the Glass* 27 *Seconds, the Log-line being cast every Hour.*

Hours	Knots	Fath.	Courses	Winds
1	2	3	NNE	SBW
2	4	5		
3	3	7		
4	1	9		
5	2	0		
6	3	4		
7	2	8		
8	1	7		
9	5	2		
10	3	5		
11	4	2		
12	3	1		
1	2	5		
2	3	6		
3	4	7		
4	3	2		
5	1	4		
6	5	6		
7	1	0		
8	3	1		
9	2	3		
10	3	4		
11	2	7		
12	3	9		
	75	9		

June 24. about 1 a Clock Afternoon we set Sail, with Seven other Ships; a fresh Gale, fair Weather.

By *Chap.* 4.

$$\begin{array}{r} .915 \\ 75.9 \\ \hline 8235 \\ 4575 \\ 6405 \\ \hline \end{array}$$

dist.run by l. 69.4485 m.

Diff.lat.by log—64.1 m.
Depart.by log—26.6 m.
Diff.long.by log-42 mil.

Co-☉ Merid.alt. 28°.13′
☉ Dec. North-—23.27

Lat. by observat.--51.40

Long.corrected-65.4 m.
Therefore the Ships true Long.is 1°. 5′ *June* 25.
Lat. by Log. 51°. 4′ N°.

June

Hours	Knots	Fath.	Courses	Winds
1	3	5	NE	SW
2	4	6		
3	5	7		
4	4	6		
5	3	5		
6	2	7		
7	4	9		
8	3	8		
9	2	7		
10	1	9		
11	4	5		
12	6	8		
1	5	6	NNE	SW
2	6	5		
3	4	7		
4	6	3		
5	6	4		
6	7	5		
7	6	8		
8	3	4		
9	2	5		
10	7	6		
11	4	7		
12	3	8		

June 26. we had fair Weather, a ſmooth Sea, the Wind increaſing by degrees.

.915	.915
49.2	65.8
1830	7320
8235	4575
3660	5490
diſt.45.0180	*diſt*.60.2070

iff. latit. by log—93 m.
eparture by log-57 m.
iff.long. by log-93.5 m.
Latitude by log—53°.13′

Co-⊙ Merid.alt.-29°.36′
⊙ Dec. North-+23.22

Latit. obſerved—-52.58

Diff.lat.by obſerv. 1°.33′
Diff.long.corrected 78m.
Ships true longit.--2°.25′
Courſe corr.N°.31°.36′ E

June

Hours	Knots	Fath.	Courses	Winds
1	4	6	ENE	West
2	5	4		
3	3	7		
4	6	1		
5	5	8		
6	5	7		
7	5	6	NEBN	
8	6	4		
9	6	1		
10	6	2		
11	4	9		
12	4	8		
1	7	4	NEBE	WSW
2	7	5		
3	7	6		
4	8	1		
5	8	2		
6	8	3		
7	7	9	EBN	
8	7	8		
9	7	6		
10	6	8		
11	6	5		
12	6	4		

June 27. we had thick hazy Weather, towards morning it cleared up, and we ſaw about 4 a Clock 3 Sail on the Starboard bow.

.915	.915
31.3	34
2745	3660
915	2745
2745	31.110
28.6395	

.915	.915
47.1	43
915	2745
6405	3660
3660	39.345
43.0965	

Diff.lat.by log.—69.2 m.
Depart.by log.-117.8 m.
Diff.long.by log.-200 m,
Co. cor. N°.59.46 Eaſtw.
Latit. by log.54°.07′ N°.

Co-☉ merid.alt.-30°.38′
☉ Declin.North—23.22

Lat. by obſerv.54.00 N°.

Diff.lat.by Obſerv.62 m.
Diff. long.correct. 61 m.
Ships true longit.--3°.26′

The

The same Log cast every two hours.

Hours	Knots	Fath.	Courses	Winds
2	2	1	ENE	West
4	1	6		
6	1	7		
8	1	8		
10	1	9		
12	1	3		
2	1	6	NE	
4	2	1		
6	2	2		
8	2	2		
10	2	4		
12	2	5		

June 28. Fair Weather, little Wind, we saw 4 Sail more.

.915	.915
20.8	26.0
7320	54900
183 0	1830
19.0320	23.7900

Diff. lat. by log.--24.3 m.
Depart. by log.--34.6 m.
Course by log. N°. 55°. E.
Lat. by log.--54°.24′ N°.
Diff. long. by log. 58 m.

Co-☉ merid. alt.--31°.36
☉ Dec. North---23.20
Ships lat. by obs. 54.56 N°

Diff. lat. by observ. 50 m.
Diff. long. correct. 122 m.
Ships true longit. 5°.48′.

EXPLICATION.

June 24. The Ship failed upon one Courſe, *viz.* NNE, and the Log was caſt every hour: Therefore add up all the Knots and Fathoms (or Decimal parts of a Knot) and the Sum will be 75.9 or 75 Knots $\frac{9}{10}$.

Thus in the Log-Tables, *Chap.* 4. find the Table entitled 27 Seconds (which is the ſuppoſed quantity of time your Glaſs conſiſts of) and againſt one Knot ſtands .915, which multiplyed by 75.9 (the number of Knots run in 24 hours) the Product 69.$\frac{4}{10}$ gives the number of Miles the Ship ſhall run that Day.

Thus the Courſe (always ſuppoſed to be corrected according to the Rules in *Chap.* 9. *P.* 158.) and the Ships diſtance run by Log, are both known. Therefore by *Caſe* 1. of Plain Sailing, you may find the Ships latitude by Log to be 51°. 04′ North, and her longitude by log may be found by *Caſe* 1. of Sailing by the true Sea Chart, to be 00°. 42′.

But by a good Obſervation I find the Ship is in the North latitude of 51°. 40, from which ſubtract the latitude you came from, *viz.* 50°. 06, the remainer is 1°. 40′ or 100 miles, for the Ships true diff. latitude required.

Then find the meridional parts for the latitude of 51°. 40′, *viz.* 3632, and alſo for 50°. 00, *viz.* 3474, ſubtract the leſſer from the greater, the remainer 158 is the difference of the latitude enlarged, then ſay,

As Radius sine of 90°. 00′ —————— 1000000
Is to diff. latit. enlarged 158 Miles——— 219865
So is tangent Course 22°. 36 ——— - ——— 961722

To Ships true diff. long. 65.4 Miles — — 18158

Therefore the Ships true longitude is 1°. 5′.

Again, To find the Ships difference of long. by Log. Seeing that the Course is NNE, and distance 69.4 Miles therefore by the Tables of Latitude and Departure, it is evident, That the Ships difference of latit. by Log. is 64.1 Miles, and her Departure is 26.6 Miles, and consequently, by 1. *Rule* 1. *Chap.* 12. the Ships latitude by Log. is 51°. 4′. North, find the Meridional parts for the Latitude you came from, *viz.* 50°. 06, and that Latitude you are come into by Log. which by the Tables in *Page* 138, are as follow, *viz.* 3474 and 3575, subtract the lesser from the greater, and the remainer 101. is the difference of Latitude enlarged. Then say,

As Radius sine of 90°. 00 - - — 1000000
Is to difference of Latitude enlarged 101-200432
So is tangent Course 22°. 36 —— ——— 961722

To Ships diff. Long. by Log. 41.8 Miles — 16215

Or you may find the Ships difference of Long. by Log. according as I directed you in *Case* 3. of Sailing by the true Sea Chart; for the departure in this case is nothing but the Ships distance run East or West in that.

Tun

June 26.

In this days motion, the Ship ſails upon two ſeveral Courſes, *viz.* NE and NNE, to find her diſtance run upon each Courſe, add up all the Knots and Tenths the Ship run NE, which was for 12 hours time, and the Sum is 49.2, that is 49 Knots, and $\frac{2}{10}$ of a Knot, conſequently her diſtance run will be 45 Miles upon that Courſe. Alſo her diſtance run upon the NNE Courſe will be 65.8 Miles, with which you may proceed according to the Directions in *Page* 198 and 199, and having found the Ships difference of Lat. and departure, her Courſe may eaſily be diſcovered by *Caſe* 6. of Plain Sailing, and then the Ships Latitude and Longitude by Log. may be found as afore, as alſo her corrected difference of Longit.

The laſt thing I have to obſerve to you is, that *June* 28. the Log was caſt but once every 2 hours. The firſt Courſe was ENE, the Sum of the Knots and Fathoms (or Decimals of a Knot) is 10.4, which doubled, makes 20.$\frac{8}{10}$ Knots. The other Courſe is NE. and the Sum of the Knots is 13, which being doubled, makes 26, theſe two Numbers multiplied by the reſponding number in the Log-Tables, give the Ships diſtance as afore. Thus you ſee how eaſie a thing it is to keep a good account of the Ships reckoning by Log, and alſo how to correct this Account by a good Obſervation. The want of theſe or the like plain and demonſtrative Rules, has been the occaſion of many Erroneous Accounts.

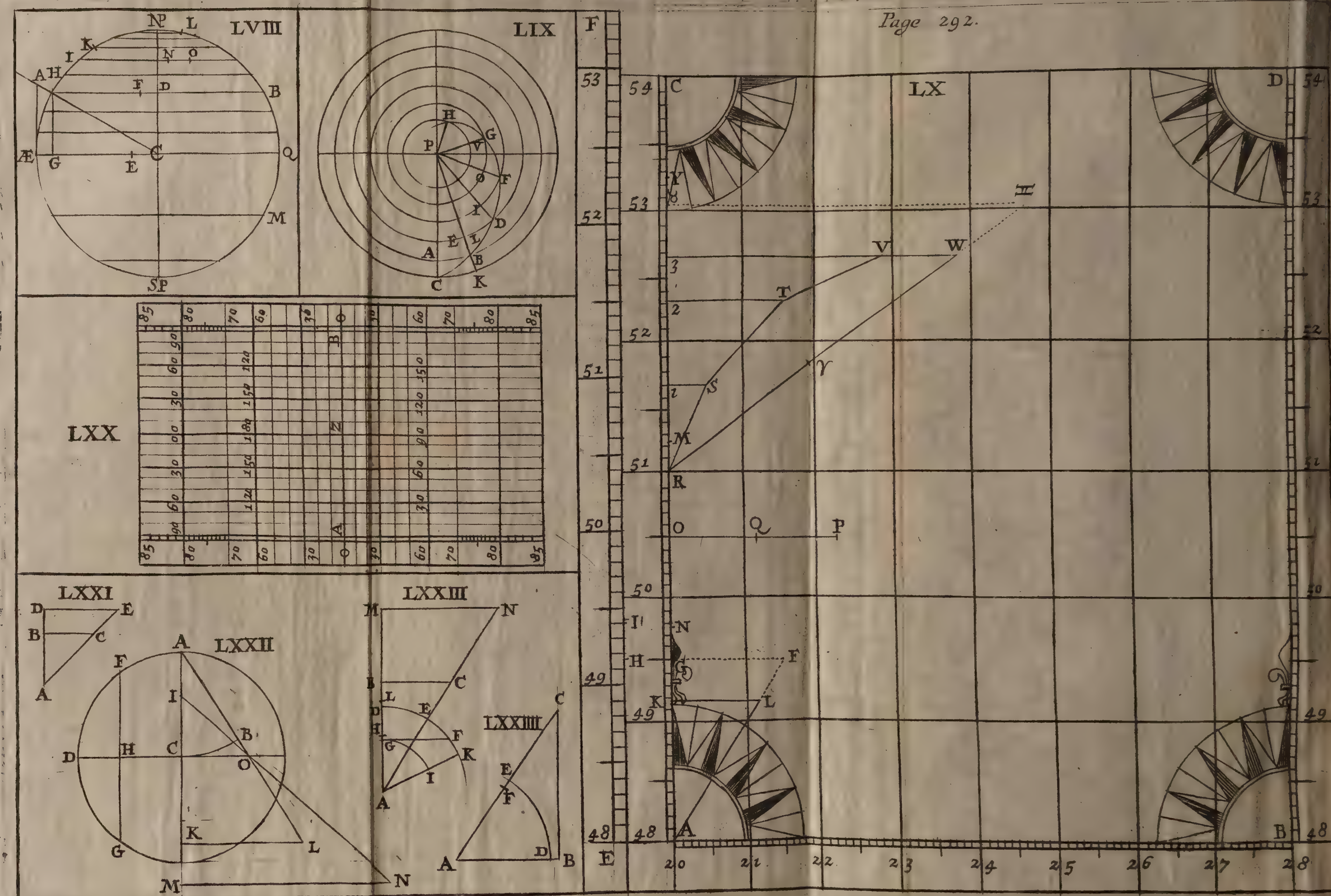
To conclude, it were much to be wished, that our Seamen would be at the pains first to study and then to practise those Rules I have delivered in Chap. 2. and Chap. 7. the one teaching how to find the Latitude of any place whereever they come (and that by a Quadrant of 18 or 20 Inches Radius, furnished with an Index and Sights, one side of the Quadrant lying in an Horizontal Position) the other shewing how (as in *Page* 7 ..) to find the true Longitude of the same place upon the Shoar by help of a good Telescope 10 or 12 Foot long.

By this means would the business of Geography be compleat, and thereby the Art of Navigation would attain its desired perfection.

And for want of this due care, not only the Longitudes of Places (which in themselves are difficult to be found) are many times two or three degrees, and sometimes more, different from the truth; but also the Latitudes of several Places are false set, both in our Geographical Maps and Tables, as you may see in the Voyage to *Siam* 1685.

Now seeing the Latitudes and Longitudes of Places are too many times falsly set down, how is it possible to keep a true account in Sailing between any two of these Places?

FINIS.


LVIII
LIX
LX
LXX
LXXI
LXXII
LXXIII
LXXIIII

ASTRONOMICAL
TABLES
OF THE
SUN and *STARS.*

SHEWING

The Sun's Right Aſcenſion and Declination for every Degree of the Sun's Place in the *Ecliptic.*

AND

The Longitude, Latitude, Right Aſcenſion and Declination of moſt of the Fixed Stars in both *Hemiſpheres.*

Rectified for the Year 1700.

LONDON,
Printed by *J. Orme*, for *Chriſtopher Huſſey*, at the three *Flower-de-Luce's* in *Little Britain*, 1695.

☉ place ♈ D.	☉ R.Aſ. H M.	☉ Dec. D. M	N or S	☉ place ♉	☉ R.Aſ. H. M	☉ Dec. D. M	N or S	☉ place ♊	☉ R.Aſ. H M	☉ Dec. D. M	N or S
D.1	0. 4	0.24	N	D.1	1.55	11.51	N	D.1	3.55	20.25	N
2	0. 7	0.48	N	2	1.59	12.13	N	2	4.00	20.37	N
3	0.11	1.12	N	3	2.03	12.33	N	3	4.04	20.49	N
4	0.15	1.36	N	4	2.07	12.53	N	7	4.08	21.00	N
5	0.18	2.00	N	5	2.11	13.15	N	5	4.12	21.11	N
6	0.22	2.24	N	6	2.14	13.33	N	6	4.16	21.22	N
7	0.26	2.48	N	7	2.18	13.55	N	7	4.21	21.32	N
8	0.29	3.11	N	8	2.22	14.13	N	8	4.25	21.43	N
9	0.33	3.35	N	9	2.26	14.32	N	9	4.29	21.52	N
10	0.37	3.58	N	10	2.30	14.50	N	10	4.33	22.00	N
11	0.41	4.22	N	11	2.3	15.10	N	11	4.38	22.10	N
12	0.44	4.46	N	12	2.38	15.29	N	12	4.42	22.17	N
13	0.48	5.09	N	13	2.42	15.47	N	13	4.46	22.25	N
14	0.52	5.33	N	14	2.46	16.05	N	14	4.51	22.33	N
15	0.55	5.56	N	15	2.50	16.23	N	15	4.55	22.40	N
16	0.59	6.18	N	16	2.54	16.40	N	16	4.59	22.46	N
17	1.03	6.42	N	17	2.58	16.56	N	17	5.04	22.52	N
18	1.06	7.05	N	18	3.02	17.1	N	18	5.08	22.58	N
19	1.10	7.28	N	19	3.06	17.31	N	19	5.12	23.02	N
20	1.14	7.50	N	20	3.10	17.48	N	20	5.17	23.07	N
21	1.18	8.12	N	21	3.14	18.03	N	21	5.21	23.12	N
22	1.21	8.36	N	22	3.18	18.19	N	22	5.25	23.15	N
23	1.25	8.58	N	23	3.22	18.35	N	23	5.30	23.19	N
24	1.29	9.21	N	24	3.26	18.49	N	24	5.34	23.21	N
25	1.33	9.43	N	25	3.31	19.05	N	25	5.38	23.24	N
26	1.36	10.04	N	26	3.34	19.18	N	26	5.43	23.26	N
27	1.40	10.26	N	27	3.39	19.32	N	27	5.47	23.28	N
28	1.44	10.48	N	28	3.43	19.45	N	28	5.51	23.29	N
29	1.48	11.09	N	29	3.47	19.59	N	29	5.56	23.30	N
30	1.52	11.30	N	30	3.51	20.12	N	30	6.00	23.30	N

☉ place	☉ R.Af.	☉ Dec	N° or S°	☉ place	☉ R. Afc.	☉ Dec.	N° or S°	☉ place	☉ R. Afc	☉ Dec.
♋	H M.	D. M		♍	H. M	D. M		♌	H. M.	D. M.
D.1	6.04	23.30	N	D.1	8.13	19.57	N	D.1	10.12	11.06
2	6.09	23.29	N	2	8.17	19.43	N	2	10.16	10.45
3	6.13	23.27	N	3	8.21	19.29	N	3	10.29	10.23
4	6.18	23.2[illegible]	N	4	8.25	19.15	N	7	10.24	10.01
5	6.22	23.23	N	5	8.29	20.62	N	5	10.27	9.43
6	6.26	23.21	N	6	8.34	18.46	N	6	10.31	9.17
7	6.31	23.18	N	7	8.38	18.32	N	7	10.35	8.55
8	6.35	23.15	N	8	8.42	18.16	N	8	10.39	8.32
9	6.39	23.12	N	9	8.46	18.00	N	9	10.42	8.09
10	6.44	23.08	N	10	8.50	17.45	N	10	10.46	7.47
11	6.48	23.04	N	11	8.54	17.18	N	11	10.50	7.24
12	6.52	23.01	N	12	8.58	17.11	N	12	10.53	7.01
13	6.57	12.58	N	13	9.02	16.54	N	13	10.57	6.38
14	7.01	22.50	N	14	9.06	16.38	N	14	11.01	6.15
15	7.05	22.44	N	15	9.10	19.20	N	15	11.05	5.52
16	7.09	22.36	N	16	9.14	16.02	N	16	11.08	5.29
17	7.14	22.28	N	17	9.18	15.44	N	17	11.12	5.25
18	7.28	22.20	N	18	9.22	15.26	N	18	11.16	4.42
19	7.22	22.11	N	19	9.26	15.07	N	19	11.20	4.18
20	7.27	22.00	N	20	0.30	14.47	N	20	11.23	3.54
21	7.31	21.52	N	21	9.34	14.28	N	21	11.27	3.31
22	7.36	21.43	N	22	9.38	14.10	N	22	11.31	3.07
23	7.40	21 32	N	23	9.41	13.52	N	23	11.34	2.4[illegible]
24	7.44	21.21	N	24	9.45	13.30	N	24	11.38	2.20
25	7.48	21.10	N	25	9.49	13.11	N	25	11.42	1 5[illegible]
26	7.52	20.58	N	26	6.53	12.51	N	26	11.46	1.3[illegible]
27	7.56	20.47	N	27	9.57	12.30	N	27	11.49	1.08
28	8 00	20.35	N	28	0.01	12.09	N	28	11.53	0.44
29	8.05	20.23	N	29	10.65	11.48	N	29	11.57	0.20
30	8.[illegible]	20.10	N	30	10.08	11.27	N	30	12.00	0.00

	☉ R. Asc.	☉ Dec.	N or S	☉ place	☉ R. Asc.	☉ Dec.	N or S	☉ place	☉ R. Asc.	☉ Dec.	N or S
	H. M.	D. M		♏	H. M	D. M		♐	H. M	D. M.	
1	12.04	0.24	S	D.1	13.55	11.51	S	D.1	15.55	20.25	S
2	12.07	0.48	S	2	13.59	12.13	S	2	15.59	20.37	S
3	12.11	1.12	S	3	14.03	12.33	S	3	16.04	20.49	S
4	12.15	1.36	S	4	14.07	12.54	S	4	16.08	21.00	S
5	12.18	2.00	S	5	14.11	13.15	S	5	16.12	21.19	S
6	12.22	2.24	S	6	14.15	13.33	S	6	16.16	21.22	S
7	12.26	2.48	S	7	14.19	13.55	S	7	16.21	21.32	S
8	12.29	3.11	S	8	14.23	14.13	S	8	16.25	21.43	S
9	12.33	3.35	S	9	14.26	14.32	S	9	16.29	21.51	S
10	12.37	3.58	S	10	14.30	14.50	S	10	16.33	22.00	S
11	12.40	4.22	S	11	14.34	15.10	S	11	16.37	22.10	S
12	12.44	4.46	S	12	14.38	15.29	S	12	16.42	22.17	S
13	12.48	5.09	S	13	14.42	15.47	S	13	16.46	22.25	S
14	12.52	5.33	S	14	14.46	16.05	S	14	16.50	22.33	S
15	12.55	5.56	S	15	14.49	16.23	S	15	16.55	22.39	S
16	12.59	6.18	S	16	14.53	16.40	S	16	16.59	22.46	S
17	13.03	6.42	S	17	14.57	16.56	S	17	17.03	22.52	S
18	13.06	7.05	S	18	15.02	17.14	S	18	17.08	22.58	S
19	13.10	7.28	S	19	15.06	17.31	S	19	17.12	23.02	S
20	13.14	7.50	S	20	15.1[illegible]	17.48	S	20	17.16	23.07	S
21	13.18	8.[illegible]2	S	21	15.1[illegible]	18.03	S	21	17.21	23.12	S
22	13.21	8.36	S	22	15.18	18.19	S	22	17.25	23.15	S
23	13.25	8.58	S	23	15.22	18.35	S	23	17.29	23.19	S
24	13.29	9.21	S	24	15.26	18.49	S	24	17.34	23.21	S
25	13.33	9.43	S	25	15.30	19.05	S	25	17.38	23.24	S
26	13.36	10.04	S	26	15.3[illegible]	19.18	S	26	17.43	23.26	S
27	13.40	10.25	S	27	15.39	19.32	S	27	17.47	23.28	S
28	13.44	10.48	S	28	15.43	19.45	S	28	17.51	23.29	S
29	13.47	11.09	S	29	15.47	19.59	S	29	17.56	23.29	S
30	13.51	11.30	S	30	15.51	20.[illegible]2	S	30	18.00	23.[illegible]0	S

☉ place	☉ R. Asc.	☉ Dec.	No or So	☉ place	☉ R. Asc.	☉ Dec.	No or So	☉ place	☉ R. Asc.	☉ Dec.
♑	H. M.	D. M.	So	♒	H. M.	D. M.	So	♓	H. M.	D. M.
D. 1	18.04	23.30	S	D. 1	20.13	19.57	S	D. 1	22.12	11.06
2	18.09	23.29	S	2	20.17	19.43	S	2	22.16	10.44
3	18.13	23.27	S	3	20.21	19.29	S	3	22.20	10.23
4	18.17	23.26	S	4	20.25	19.15	S	4	22.24	10.01
5	18.22	23.24	S	5	20.29	19.02	S	5	22.27	9.39
6	18.26	23.21	S	6	20.34	18.46	S	6	22.31	9.17
7	18.31	23.18	S	7	20.38	18.32	S	7	22.35	8.55
8	18.35	23.15	S	8	20.42	18.16	S	8	22.39	8.32
9	18.39	23.11	S	9	20.46	18.00	S	9	22.42	8.09
10	18.44	23.06	S	10	20.50	17.45	S	10	22.46	7.47
11	18.48	23.01	S	11	20.54	17.28	S	11	22.50	7.20
12	18.52	22.57	S	12	20.58	17.11	S	12	22.54	7.01
13	18.56	22.51	S	13	21.02	16.54	S	13	22.57	6.38
14	19.00	22.45	S	14	21.06	16.38	S	14	23.00	6.15
15	19.05	22.38	S	15	21.10	16.20	S	15	23.04	5.52
16	19.09	22.31	S	16	21.14	16.02	S	16	23.08	5.29
17	19.14	22.24	S	17	21.18	15.44	S	17	23.12	5.05
18	19.18	22.16	S	18	21.22	15.26	S	18	23.16	4.42
19	19.22	22.08	S	19	21.26	15.07	S	19	23.20	4.18
20	19.27	21.59	S	20	21.30	14.47	S	20	23.23	3.54
21	19.31	21.50	S	21	21.34	14.28	S	21	23.27	3.31
22	19.35	21.41	S	22	21.37	14.10	S	22	23.31	3.07
23	19.39	21.30	S	23	21.41	13.52	S	23	23.34	2.44
24	19.44	21.20	S	24	21.45	13.30	S	24	23.38	2.20
25	19.48	21.09	S	25	21.49	13.11	S	25	23.42	1.56
26	19.52	20.58	S	26	21.53	12.51	S	26	23.46	1.32
27	19.56	20.47	S	27	21.57	12.30	S	27	23.49	1.08
28	20.00	20.35	S	28	22.01	12.09	S	28	23.53	0.44
29	20.05	20.23	S	29	22.04	11.48	S	29	23.57	0.20
30	20.09	20.10	S	30	22.08	11.27	S	30	24.00	0.00

A TABLE *containing the Names of the Fixed Stars Rectified for the Year* 1700.

URSA Minor: Or,

LAST Star in the Tayl, called the *Pole-Star* —
Uppermost Guard ——
Lowermost Guard ——

URSA Major: Or,

Brightest in the Right Knee ——
Upper pointer, *Dubbe* ——
Lower pointer ——
Upper following in the Square ——
Lower in the same ——
In the Root of the Tayl, *Aliot* ——
Second in the Tayl ——
In the end of the Tayl, *Benenacz* ——
Cor Caroli ——

DRACO.

Former of the two Bright ones in the Head ——
Bright one in the Head, *Arato Ras Aben* ——
Last but one in the Tayl ——
Last in the Tayl ——

CEPHEUS.

Longitude D. M. S.		Latit. D. M.	N or S	Decl. D. M.	N or S	R. Asc. H. M.	Magni.
The Little B E A R.							
22.25.50	♊	66.02	N	87.42	N	00.44	2
8.39.50	♌	72.51	N	75.30	N	21.10	2
16.04.20	♌	75.23	N	73.10	N		3
The Great B E A R.							
1.55.50	♌	34.34	N	53.02	N	9.05	3
10.57.20	♌	49.40	N	63.32	N	10.45	2
15.06.50	♌	45.03	N	57.58	N	10.43	2
26.48.50	♌	51.37	N	58.41	N	11.56	2
26.08.20	♌	47.06	N	55.23	N	11.37	2
4.33.20	♍	54.18	N	57.39	N	12.40	2
11.19.50	♍	56.22	N	56.41	N	13.12	2
22.35.20	♍	54.25	N	50.53	N	13.35	2
19.06.20	♍	40.06		40.25	N	12.40	2
The D R A G O N.							
7.42.20	♐	75.21½	N	52.32	N	17.24	3
23.47.20	♐	75.03½	N	51.35	N	17.52	3
11.49.50	♌	61.33	N	71.25	N	12.18	3
6.00.50	♋	57.07	N	71.00	N	11.15	3

CEPHEUS.

CEPHEUS.

In his Girdle- ——————————————
In his Shoulder, *Alderah*—————————
In his Left Foot ——————————————

BOOTES.

In his Shoulder, *Ceginus* ——————————
In his Head———————————————
In his Right Shoulder, above the Crown ———
Below the Right Arm in the Hip, *Mezen* ———
In his Skirt, *Arcturus*, *Azimeck*, *Alrameck* ———

CORONA BOREA.

Brightest, *Alfeta* ———————————
Next the Bright Star ———————————

HERCULES.

In his Head, *Ras Algiether*, *Aracc*- ————
In his Right Shoulder ——————————
Left but one in his Right Arm, *Marsic*———
In his Left Shoulder ——————————
In his Left Knee ———————————

LYRA.

Brightest, *Asengue*, *Allore*, *Brinesce*———
Northern of the two in the Yoke- ——————
Next Bright one Eastward-————————

CYGNUS.

CEPHEUS.

Longitude D. M. S.		Latitud. D. M.		Declin. D. M.		R. Ascen. H. M	Magn.
1.36.20	♉	71.07	N	69.17	N	21.25	3
8.36.20	♉	68.54	N	61.17	N	21.11	3
25.46.20	♉	64.28	N	75.50	N	23.33	3

BOOTES.

Longitude D. M. S.		Latitud. D. M.		Declin. D. M.		R. Ascen. H. M	Magn.
14.28.50	♎	49.33½	N	39.17	N	14.23	3
2 .06.50	♎	54.15½	N	41.38	N	15.15	3
28.52.50	♎	49.01	N	34.28	N	15.04	3
23.52.20	♎	40.40	N	28.22	N	14.32	3
20.02.20	♎	31.02½	N	20.50	N	14.02	1

The Northern Crown.

Longitude D. M. S.		Latitud. D. M.		Declin. D. M.		R. Ascen. H. M	Magn.
8.01.50	♏	44.23	N	27.46	N	15.22	2
10.37.50	♏	44.52	N	27.04	N	15.41	4

HERCULES.

Longitude D. M. S.		Latitud. D. M.		Declin. D. M.		R. Ascen. H. M	Magn.
11.54.20	♐	37.23	N	14.49	N	17.01	3
26.50.50	♏	42.18	N	22.40	N	16.17	3
24.59.20	♏	40.05½	N	19.55	N	16.09	3
10.33.20	♐	47.47	N	25.13	N	17.03	3
24.19.20	♐	60.47½	N	46.14	N	17.31	3

The HARP.

Longitude D. M. S.		Latitud. D. M.		Declin. D. M.		R. Ascen. H. M	Magn.
11.06.20	♑	61.47	N	38.32	N	18.27	1
14.26.50	♑	56.05	N	33.04	N	18.38	3
17.34.20	♑	55.06	N	32.19	N	18.47	3

The

CYGNUS.

In the Bill, *Albireo* ——————————
In her Breast——————————————
In her Tayl, *Arides* ——————————
First & brightest in the Bend of the higher Wing
Middlemost in the lower Wing ——————

CASSIOPEIA.

In her Breast, *Schedir* ——————————
In her Bending towards the Hip ——————
In her Knee ————————————
In her Leg ——————————————
Bright one in the Chair ————————

PERSEUS.

In his Right Shoulder ——————————
Bright one in his side, *Algenib* ——————
Next in the Bend of his side- ——————
Medusa's Head, *Algol* ——————————

AURIGA.

In his Right Shoulder ——————————
In his Left Shoulder, *Capella* ——————
In his Right Foot ————————————

OPHI-

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Ascen H. M.	Magn.
The SWAN.							
27.07.20	♑	49.02	N	27.22	N	19.19	3
20.48.20	♒	57.09½	N	39.20	N	20.12	3
1.16.20	♓	59.56	N	44.14	N	20.31	2
12.16.20	♒	64.28	N	44.27	N	19.32	3
29.06.20	♒	43.44	N	29.05	N	21.01	3
CASSIOPEIA.							
3.40.50	♉	46.35	N	54.54	N	0.24	3
9.50.50	♉	48.46	N	59.04	N	0.40	3
13.44.20	♉	46.22	N	58.39	N	1.06	3
20.36.50	♉	47.29	N	62.10	N	1.33	3
0.58.50	♉	51.14	N	32.29	N	23.53	3
PERSEUS.							
26.09.20	♉	34.30	N	52.25	N	2.45	3
27.40.20	♉	30.05	N	48.59	N	2.55	2
0.38.20	♊	27.14	N	46.46	N	3.22	3
22.00.00	♉	22.22½	N	39.45	N	2.49	3
AURIGA.							
27.15.20	♊	21.27½	N	44.45	N	5.46	2
17.39.20	♊	22.50½	N	45.38	N	4.54	1
18 22.50	♊	5.20	N	28.21	N	5.07	2

OPHIUCUS.

In his Head, *Ras Alangue* ——
Uppermost in his Right Shoulder ——
Lowermost in *ditto* ——
Northern in the Left Hand, *Jed* ——

SERPENS OPHIUCHI.

In the Upper Jaw ——
In the Temples ——
In the Eduction of the Neck ——
Brightest in the middle of the Neck ——
Antipenultimate in the Tayl ——
Penultimate ——
Ultimate or last in the Tayl ——

AQUILA.

In the Neck ——
Bright one near the Shoulder, *Alcair* ——
Next above it in the left Shoulder ——
In the Tayl ——

ANTINOUS.

Northern in the Right Foot ——
In his Right Arm ——
In his Right Knee ——

DE L

SERPENTARIUS.

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Ascen H. M.	Magn.
18.13.20	♐	35.57	N	12.51	N	17 21	3
21.08.20	♐	28.01	N	4.45	N	17.29	3
22.28.20	♐	26.11	N	2.22	N	17.33	3
28.07.50	♏	17.19	N	2.53	S	15.59	3

The Serpent of OPHIUCUS.

15.47.20	♏	39.06½	N	20.53	N	15.38	3
18.29.20	♏	35.25	N	16.45	N	15.43	3
15.44.20	♏	34.27½	N	16.27	N	15.32	3
17.53.20	♏	25.35	N	7.25	N	15.30	2
25.57.20	♐	19.57	N	3.31	S	17.45	3
1.35.20	♑	20.37	N	2.53	S	18.06	3
11.33.20	♑	26.59	N	3.54	N	18.41	3

The EAGLE.

28.16.20	♑	26.49½	N	5.46	N	19.40	3
27.56.20	♑	29.21½	N	8.11	N	19.39	2
26.49.20	♑	31.18	N	9.56	N	19.32	3
15.38.20	♑	36.16	N	13.28	N	18.51	3

ANTINOUS.

13.[illegible]9.20	♑	17.41	N	5.15	S	18.50	3
19.24.20	♑	24.56	S	2.37	N	19.10	3
20 40.20	♑	14.28	N	7.33	S	19 21	3

DELPHINUS.

Bright Star of the Tayl
First Star in the Rhomb
Second in the same side
Third
Fourth

PEGASUS.

In the Mouth, *Enif*
Brightest in the Neck
Bright one in the Right Knee
First Star in the Wing, *Marchab*
In the Thigh, *Scheat*
End of the Wing

ANDROMEDA.

In her Head
Northern and brightest in the Left Shoulder
Southern and brightest in her Girdle, *Mirach*
Bright one in the South Foot, *Alamech*

Northern Constellations.

ARIES.

Bright Star in the top of the Head

TAURUS.

South Eye, *Aldebaran*, *Palilitium*
North Eye
End of the South Horn

GEMINI

Longitude D. M. S.		Latitude D. M.		Declin. D. M		R. Ascen. H. M	Magn.

The DOLPHIN.

9.55.20	♒	29.08	N	10.20	N	20.18	3
12.19.20	♒	31.57½	N	13.36	N	20.24	3
13.13.50	♒	33.05	N	14.54	N	20.26	3
14.59.50	♒	32.00	N	14.18	N	20.33	3
15.15.20	♒	32.47	N	15.06	N	20.33	3

PEGASUS.

27.45.20	♒	22.07½	N	8.31	N	21.30	3
12.02.50	♓	17.41	N	9.47	N	22.27	3
21.33.20	♓	35.07½	N	28.35	N	22.28	3
19.19.50	♓	19.26	N	13.38	N	22.50	2
25.12.20	♓	31.07	N	26.27	N	22.49	2
5.01.20	♈	12.35	N	13.31	N	23:58	2

ANDROMEDA.

10.10.20	♓	25.42	N	27.27	N	23.52	2
17.42.50	♈	24.20	N	29.14	N	00.24	3
25.42.20	♈	25.59	N	33.52	N	00.51	2
10.02.20	♓	27.46½	N	40.52	N	01.46	2

ARIES. ♈

3.29.20	♉	9.57	N	22.02	N	01.50	3

TAURUS. ♉

5.35.50	♊	5.31	S	15.42	N	04.19	1
4.16.20	♊	2.36½	S	18.38	N	04.12	3
20.35.20	♊	2.14	S	20.55	N	05.21	3

GEMINI.

In the Head of *Castor*, *Apollo* ——————
In the lower Head, *Pollux* ——————
In the Left Knee ——————
First in the Foot of *Castor* ——————
Bright one in the Foot of *Pollux* ——————

CANCER.

In the Breast, *Præsepe* ——————
In the South Claw ——————

LEO.

Middle bright one in the Neck, *Alezet* ——————
Lyon's Heart, *Basiliscus*, *Regulus* ——————
Lyon's Back ——————
Bright Star in his Tayl, *Deneb* ——————

VIRGO.

Brightest in the Northern Wing, *Vindemiatrix* —
The Virgin's Spike, *Azimech* ——————
In the end of the South Wing ——————

Southern Constellations.

LIBRA.

Bright one in the South Scale, *Zubenelgenubi* ——
In the Fulciment of the Beam, *Zubenesch-hemali* —
First of the three in the North Scale ——————

SCOR-

Longitude D. M. S.		Latitude D. M		Declin. D. M		R.Afcen H. M	Magn.
G E M I N I. ♊							
16.04.20	♋	10.0	N	32.29	N	07.16	2
19.06.20	♋	6.38	N	28.43	N	07.27	2
5.45.50	♋	2.11½	N	25.30	N	06.26	3
29.21.20		0.58	S	22.32	S	06.03	3
05.54.20	♋	6.48½	S	16.38	S	06.20	2
C A N C E R. ♋							
03.09.50	♌	1.14	N	20.35	N	08.23	4
09.26.50	♌	5.08	S	12.59	N	18.42	3
L E O. ♌							
25.22.20	♌	8.47	N	21.20	N	10.03	2
25.40.20	♌	0.26	N	13.26	N	09.52	1
7.04.20	♍	14.23	N	22.44	N	11.02	2
17.26.20	♍	12.18	N	16.16	N	11.34	1
V I R G O. ♍							
5.46.20	♎	16.15½	N	12.36		12.48	3
19.39.20	♎	1.59	S	9.32		13.10	1
22.55.20	♍	0.43	N	3.28	N	11.35	3
L I B R A. ♎							
10.54.20	♏	0.26	N	14.36	S	14.35	2
15.11.20	♏	8.35	N	8.12	S	15.01	2
20.56.20	♏	4.28	N	13.42	S	15.19	3

SCORPIO.

North bright one in the Front ——————
Second in the Front ——————
Third in the Front ——————
Scorpion's Heart, *Antares*——————

SAGITTARIUS.

In the Southern part of his Bow ——————
In his Left Shoulder——————

CAPRICORNUS.

First bright one in the Tayl, *Deneb Algeni* ——
Second bright one in the Tayl ——————

AQUARIUS.

Brightest in his Left Shoulder ——————
Brightest in his Right Shoulder ——————
South in the right Shank, *Scheat*——————
The last in the Effusion, *Fomahant* ——————

PISCES.

South of the two in the Head ——————
First of the 3 Bright ones in the South Line-——
Middlemost of them three-——————
Middle and bright one of the Knot-——————

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R. Ascen. H. M.	Magn.
SCORPIO ♏							
28.59.20	♏	1.05	N	18.53	S	15.48	3
28.23.10	♏	1.54½	S	21.50	S	15.43	3
28.45.10	♏	5.22½	S	25.10	S	15.42	3
5.32.10	♐	4.27	S	25.40	S	16.11	1
SAGITTARIUS. ♐							
0.52.10	♑	10.55	S	34.25	S	18.4	3
8.10.10	♑	3.23	S	26.38	S	18.37	3
CAPRICORNUS. ♑							
17.37.20	♒	2.26	S	17.56	S	21.28	3
19.23 20	♒	2.29	S	17.27	S	21.31	3
AQUARIUS. ♒							
19.12.50	♒	8.42	N	6.56	S	21.16	3
29.12.50	♒	10.42	N	1.44	S	15.10	3
4.45.20	♓	8.10	S	17.22	S	22.39	3
29.34.50	♒	21.00	S	31.09	S	22.41	1
PISCES. ♓							
17.13 50	♓	7.17½	N	1.32	N	16.22	4
9.59.20	♈	2.11	N	5.58	N	0.33	4
13.21.20	♈	1.05	N	6.17	N	0.48	4
22.39.20	♈	5.21	N	13.48	N	1.16	4

CETE

CETE.

Bright ✳ in her Tayl, South, *Deneb Kaitos*———
North in the Tayl ———
North in the Belly, *Beten Kaitos* ———
In the Jaw, *Menchar* ———

ORION.

In his Right Shoulder, *Bed Algense*———
In his Left Shoulder ———
Northern and first in his Belt ———
Middlemost ———
Last in the Belt ———
In his Left Foot, *Rigel*, *Algebar* ———

LEPUS.

In the Left Foot ———
Near the Back ———
Southern of the two in the Hind Feet ———
Northern of the two there ———

ERIDANUS.

Above the Foot of *Orion* in the River ———
First of the 3 in a Right Line with *Menchar* ———
Last in the River *Achernar* ———

CANIS Minor.

Brightest in the Neck ———
Bright one in his Thigh, *Procyon*, *Alschere* ———

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Ascen. H. M	Magn.

The W H A L E.

28.19.20	♓	20.47	S	19.39	S	00.28	2
26.46.20	♓	10.01	S	10.28	S	00.04	3
17.48.20	♈	20.19	S	11.46	S	01.37	3
10.10.20	♉	12.37	S	2.55	N	03.23	2

O R I O N.

[illegible]4.35.20	♊	16.06	S	7.18	N	5.39	2
16.46.20	♊	16.53	S	6.02	S	5.09	2
18.13.50	♊	23.38	S	0.35	S	5.17	2
19.17.20	♊	24.33½	S	1.25	S	5.21	2
20.29.50	♊	25.21½	S	2.08	S	5.25	2
12.40.20	♊	31.11	S	8.35	S	5.00	1

The H A R E.

15.29.50	♊	43.57	S	21.01	S	5.16	3
17.12.50	♊	41.05½	S	18.02	S	5.24	3
20.44.50	♊	45.49½	S	22.32	S	5.32	3
22.59.20	♊	44.18	S	20.56	S	5.39	3

River E R I D A N U S.

11.05.20	♊	27.54½	S	5.30	S	4.53	3
19.41.20	♉	33.13	S	14.21	S	3.44	3
10.50.10	♓	59.18½	S	58.57	S	1.23	[illegible]

Little D O G.

18.02.50	♋	13.33½	S	8.51	N	7.11	3
21.41.50	♋	15.57	S	6.00	N	7.24	2

Gre

CANIS Major.

Brighteſt in his Mouth, *Syrius*- ---
In the end of the Fore-Foot ---

COLUMBA NOACHI.

Former of the two Bright ones- ---
The following bright one ---

ARGO.

Bright ⁎ upon the Deck, near the Mizzen-Maſt
Next bright one almoſt in a right line ---
Southern of the 4 bright ones in the Hull ---
Next bright one neareſt the *Royal-Oak*- ---
Northern of the 4 bright ones there ---
Canobus, or brighteſt in the Stern, *Schemuel* ---

ROBUR CAROLINUM.

At the Root thereof ---
At the top of the Trunk- ---

HYDRA.

Hydra's Heart, *Alphard* ---
Firſt in the *Weſtern* Triangle ---

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Afcen. H. M.	Magn.

Great D O G.

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Afcen. H. M.	Magn.
9.58.50	♋	39.30	S	16.17	S	6.32	1
3.05.50	♋	41.18½	S	17.48	S	6.10	2

N O A H's D O V E.

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Afcen. H. M.	Magn.
18.06.10	♊	57.24	S	34.24	S	5.29	3
22.20.40	♊	59.15	S	35.54	S	5.41	3

The S H I P.

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Afcen. H. M.	Magn.
23.09.10	♌	64.26½	S	46.24	S	8.0	2
14.41.10	♍	67.11	S	53.33	S	8.36	2
18.53.10	♍	72.40	S	58.29	S	8.16	2
0.34.10	♎	67.06	S	57.30	S	9.06	2
24.39.10	♍	63.43	S	53.41	S	9.12	2
10.51.10	♋	75.48	S	52.28	S	6.18	1

The R O Y A L-O A K E.

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Afcen. H. M.	Magn.
27.44.10	♎	72.15½	S	68.26	S	9.09	2
24.56.10	♎	62.10	S	62.48	S	10.31	3

H Y D R A.

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Afcen. H. M.	Magn.
23.08.50	♌	22.24	S	7.23	S	9.11	1
3.52.10	♎	31.31	S	30.07	S	11.22	3

The

CORVUS.

Former of the higher in the □ of her Wing- --
The following ∗ in the other W. & in □ *Algorab*
The following of the lower, in the Square———

CENTAURUS.

Following of the two in his Loyns ——— ———
First in the Crosiers——— ——— ——— ———
Northern in the Crosiers ——— —— ——— ———
Southern in the Crosiers——— ——— ——— ——
Last in the Crosiers ——— ——— ——— ———
In the left Knee ——— —— ——— ——— ———
In the right Foot ——— ——— ——— ——— ———

LUPUS.

In the Foot near the *Centaur*'s Head——— ——— ——
In the Knee of the other hinder Foot- ——— ———

ARA.

In the middle of the Altar-——— ——— ——— ———

GRUS.

In the Head ——— ——— ——— ——— ——— ———
Bright ∗ in the left Wing ——— ——— ——— ———
In the Eduction of her Tayl——— ——— ——— ———

PHÆ-

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Ascen. H. M.	Magn.
		The CROW.					
6.36.20	♎	14.25	S	16.07	S	11.57	3
9.18.20	♎	12.07	S	14.48	S	12.15	3
13.12.20	♎	17.57	S	21.42	S	12.19	3
		The CENTAUR.					
28.12.10	♎	40.03	S	47.17	S	12.24	2
1.34.10	♏	50.18	S	57.02	S	12.00	3
2.35.10	♏	47.41	S	55.21	S	12.15	2
7.45.10	♏	52.45	S	61.22	S	12.12	2
7.31.10	♏	48.29	S	57.45	S	12.37	2
18.37.10	♏	44.00	S	58.49	S	13.43	2
25.44.10	♏	42.23	S	59.30	S	14.20	1
		The WOLF.					
20.50.10	♏	24.56½	S	41.50	S	14.39	3
19.19.10	♏	29.54	S	46.00	S	14.22	3
		The ALTAR.					
20.42.40	♐	26.25½	S	49.33	S	17.09	3
		The CRANE.					
13.14.10	♒	22.55½	S	38.39	S	21.36	3
11.39.20	♒	32.47	S	48.23	S	21.49	2
18.00.10	♒	35.20	S	48.25	S	22.24	2

The

PHÆNIX.

Bright ſtar in the Neck — — — —
In the Pynion of her right Wing — — —
In the ſide of the left Wing — — —

PAVO.

Peacock's Eye — — — —
In his Breaſt — — — — — —

INDVS.

Near the end of his Arrow — — — —

TOVCAN.

In the end of the Bill — — — —
In the Head — — — — — — —

HYDRVS.

In the Eye near *Acharnar* — — — —
Following of the two between the Clouds — —
The preceeding — — — — — — —

TRIANGVLUM AVSTRALE.

Southern in the Baſe — — — — — —
In the Vertex — — — — — —
Northern in the Baſe — — — — — —

The

Longitude D. M. S.		Latitude D. M.		Declin. D. M.		R.Ascen H. M.	Magn.

The PHÆNIX.

11.10.10	♓	40.33	S	43.49	S	0.19	2
5.20.10	♓	41.53½	S	47.24	S	23.53	3
23.48.10	♓	47.34	S	44.36	S	1.18	3

The PEACOCK.

19.37.40	♑	36.06⅓	S	57.33	S	20.01	2
24.18.10	♑	46.51½	S	66.34	S	21.00	3

The INDIAN.

14.59.20	♑	32.35	S	54.56	S	19.29	3

TOUCAN.

5.14.10	♒	45.24	S	61.50	S	22.11	3
16.06.40	♒	47.45½	S	59.51	S	23.00	3

HYDRUS.

7.33.10	♓	64.09½	S	63.10	S	1.47	3
6.01.10	♒	76.48	S	75.06	S	2.07	3
26.24.10	♑	64.27	S	78.57	S	0.14	3

The Southern Triangle.

5.13.10	♐	47.57	S	67.27	S	14.52	3
16.39.10	♐	46.00	S	68.19	S	16.17	3
7.42.10	♐	41.46	S	62.23	S	15.29	3

The use of the foregoing Tables.

Of the Sun's Declination.

THE Declination of the Sun is nothing else but an Arch of the Meridian intercepted between the Equator and the Sun, as I have observed to you in *Chap.* 1. and seeing the Sun has a different Declination every day (except when he is under the Equator) this Declination must be continually encreasing or decreasing from what it was the day before; therefore it happens that in places lying much to the Eastward or Westward of any Meridian (suppose that of *London*, the Declination of the Sun at these places shall be different from what it was at the Meridian of *London*, the same day: Then to find this difference of Declination of the Sun, observe this following Rule.

To find the Sun's Declination by these Tables.

By any Ephemeris for the Year you observe in, find the Suns true place, or degree of the Sun in the Ecliptic, with which enter the Table, entituled a Table of the Suns Declination and Right Ascension, in which against the place of the Sun (found in the Ephemeris) you have the Suns Right Ascension and Declination.

EXAMPLE 1.

May 24. 1695. I demand the Suns Right Afcenfion and Declination. By an Ephemeris for this Year, I find the Sun to be in ♊ 13°. againft which in the Tables of Declination ftand 22° 25′ for the Suns true Declination that day, and 4 H. 46 M. for his Right Afcenfion the fame day.

EXAMPLE 2.

May 7, 1695. The Sun is in ♉, 26°. 44′. I demand his Declination. Find the Suns Declination for ♉ 26, which is 19°. 18′. And alfo for 27°. which is 19°. 32′. the difference between thefe two numbers is 14′. Then fay,

If 60′ require 14′, what fhall 44′ require? Anfwer 10′. which added to 19°. 18′. the Sum 19°. 28′ is the Declination required.

And thus you may proceed for any other number of Degrees and Minutes in the Suns place. And in like manner may his Right Afcenfion be found.

To find the difference of the Suns Declination under any two Meridians on the fame Day.

Let the two places be *London* and *Surrat*, whofe difference of Longitude is about 90°. *Surrat* lying eaftward of *London*.

Becaufe the difference of Longitnde is 90°. or 6 H. therefore it is evident when the Sun is upon the Meridian at *London*, it 6 is a Clock Afternoon at *Surrat*, for the Sun fpends fix whole hours in paffing from the Meridian of the one, to the Meridian of the other; in which quantity of time there is a fenfible difference in the Suns Declination, and may be found by this

General RULE.

Find the difference of the Suns Declination between the day given and the day following, that is (as in this Example) between *May* 7. and *May* 8. for *May* 7. the Suns Declination is 19°. 28′. and for *May* 8. it is 19°. 37′. Then fubtract 19°. 28′ from 19°. 37′. the remainer 9′. is the difference of the Suns Declination for one day. Therefore 4 ½ Minutes will be the difference of the Suns Declination for half a day, or 12 hours, and 2 ¼ Minutes for 6 hours. Hence it is evident, that fuppofing the Suns Declination to be 19°. 28′ at *Surrat May* 7. it will be 19°. 30′ ¼ at *London* fix hours after.

The

The use of the Astral Table for finding the time of the Night.

RULE.

TO the Complement of the Suns Right Ascension add the Right Ascension of the Star, the Sum is the true time of that Stars Southing.

EXAMPLE.

March 27. 1695. The Suns place is 17°. and his Right Ascension, by the foregoing Table, is 1 H. 03 M. I demand what time *Castor* comes to the Meridian?

By the Tables I find the Right Ascension of *Castor* is 7 H. 16 M. and the Complement of the Sun's Right Ascension that day is 22h 57'. Therefore

	H. M.
to	22.57'
add	7.16
	30.13
	24.00
	6.13

Answer. *Castor* comes to the Meridian at 6 a Clock 13 Minutes past in the Evening.

Note. If the Sum of the Stars Right Ascension, and Complement of the Suns Right Ascension exceed 12 or 24 Hours, subtract 12 or 24 from this Sum, and the remainer shall be the time of the Stars Southing.

A Table

Dist.	¼ Point.		½ Point.		¾ Point.		1 Point.		Dist.
	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	
1	09984	0491	09752	00980	09892	01[illegible]6	09808	01951	1
2	19976	00981	19903	01960	19784	02935	19616	03592	2
3	29964	01472	29855	02941	29675	04402	29424	5853	3
4	39952	01963	39807	03921	39567	05865	39232	7804	4
5	49949	02454	49759	04901	49459	[illegible]	49040	09755	5
6	59927	02944	59711	05881	58351	8804	58847	11705	6
7	69915	03435	69663	06861	68243	10271	68655	13656	7
8	79903	03926	79615	07842	78134	11738	78463	15607	8
9	89391	04416	89567	08822	88026	13205	88271	17558	9
10	99870	04907	99519	09802	98918	14673	98079	19509	10
Dist.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dist.
	7 ¾ Points.		7 ½ Points.		7 ¼ Points.		7 Points.		

Dist.	1 ¼ Point.		1 ½ Point.		1 ¾ Point.		2 Points.		Dist.
	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	
1	09700	2430	09569	02903	09415	0333[illegible]	09239	03827	1
2	19400	04860	19139	05806	18830	0[illegible]738	18478	07654	2
3	29101	07289	28708	08709	28245	10107	27716	11481	3
4	38801	07919	38277	11612	37660	13476	39055	15308	4
5	48501	1214[illegible]	47845	1451[illegible]	47075	16845	46194	19135	5
6	58201	145[illegible]9	57415	17418	55491	20214	55433	22902	6
7	67901	1700[illegible]	66984	[illegible]0321	[illegible]590[illegible]	23[illegible]83	[illegible]4672	26789	7
8	77602	1[illegible]428	76554	23224	75323	26952	73910	30616	8
9	87302	21868	86124	26127	84738	3032[illegible]	83149	34443	9
10	[illegible]	242[illegible]8	[illegible]	2[illegible]03[illegible]	[illegible]4154	33[illegible]	[illegible]2388	[illegible]82[illegible]	10
Dist.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dist.
	6 ¾ Points.		6 ½ Points.		6 ¼ Points.		6 Points.		

Dist.	2 ¼ Points. Latit.	2 ¼ Points. Dep.	2 ½ Points. Latit.	2 ½ Points. Dep.	2 ¾ Points. Latit.	2 ¾ Points. Dep.	3 Points. Latit.	3 Points. Dep.	Dist.
1	09040	04276	08819	04714	08577	05141	08315	05560	1
2	8080	08552	17638	09428	17154	10282	16630	11112	2
3	27120	12828	26457	14142	25731	15423	24945	16668	3
4	36160	17104	35276	18856	34308	20564	33260	22224	4
5	45200	21380	44095	23570	42885	25705	41575	27780	5
6	54240	25656	52914	28284	51462	30846	49890	33336	6
7	63280	29932	61733	32998	60039	35987	58205	38892	7
8	72320	34208	70552	37712	68616	41128	66520	44448	8
9	81360	38484	79371	42426	77191	46269	74835	50004	9
10	90400	42760	88190	47140	85768	51410	83150	55560	10
Dist.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dist.
	5 ¾ Points.		5 ½ Points.		5 ¼ Points.		5 Points.		

Dist.	3 ¼ Points. Latit.	3 ¼ Points. Dep.	3 ½ Points. Latit.	3 ½ Points. Dep.	3 ¾ Points. Latit.	3 ¾ Points. Dep.	4 Points. Latit.	4 Points. Dep.	Dist.
1	08032	05957	07730	06344	07410	06716	07071	07071	1
2	16064	11914	15460	12688	14820	13432	14142	14142	2
3	24095	17871	23190	19032	22230	20148	21213	21213	3
4	32128	23828	30920	25376	29640	26864	28284	28284	4
5	40160	29785	38650	31720	37050	33580	35355	35355	5
6	48192	35742	46380	38064	44460	40296	42426	42426	6
7	56224	41699	54110	44408	51870	47012	49497	49497	7
8	64256	47656	61840	50752	59280	53728	56568	56568	8
9	72288	53613	69570	57096	66690	60444	63639	63639	9
10	80320	59570	77200	63440	74100	67160	70710	70710	10
Dist.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dep.	Latit.	Dist.
	4 ¾ Points.		4 ½ Points.		¼ Points.		4 Points.		

The Use of the Table of Difference of Latitude and Departure.

EXAMPLE 1.

A Ship Sails NEBN 8 *Miles. I demand her Difference of Latitude and Departure.*

THis Courſe is 3 Points diſtant from the No. therefore find 3 Points in the Table, and againſt 8 (under the Column of Diſtance) ſtand 6.6520 Miles for the difference of Latitude, and 4.4448 Miles for the Departure; where obſerve, That the firſt Figures towards the left hand, ſignifie Miles, and the other Figures towards the right hand ſignifie ten thouſand parts of a Mile.

EXAMPLE 2.

A Ship Sails NEBN. 8 *Miles, or* $\frac{8}{10}$ *of a Mile. I demand her difference of Latitude and Departure.*

Here we find the ſame Numbers as afore, but with this difference, *viz.* becauſe the diſtance run is leſs than a Mile, (and is ever the greateſt ſide in a right angled Triangle) therefore the difference

difference of Latitude and Departure will each of them be leſs than one mile: As in this Caſe the difference of Latitude is .66520, or ſixty ſix thouſand five hundred and twenty hundred thouſand parts of a mile, and the Departure .44448, or forty four thouſand four hundred and forty eight hundred thouſand parts of a mile.

EXAMPLE 3.

A Ship Sails NEBN 80 *Miles. I demand her Difference Latitude and Departure.*

In this Caſe you muſt note, That each of the Numerical Figures under the Column of diſtance, ſignifie 10, 20, 30, *&c.* and conſequently 8 muſt ſignifie 80; then muſt the difference of Latitude and Departure conſiſt of two Figures, and the other remaining Figures which ſtand on the right hand of theſe, will be thouſand parts of a mile: And thus it appears that the difference of Latitude is 66. 520 miles, or 66 miles and 520 thouſand parts of a mile, and the Departure 44.448, or 44 miles and 448 thouſand parts of a mile.

EXAMPLE 4.

A Ship Sails NEBN 800 *Miles.*

Here the Numerical Figures under the Column of Diſtance ſignifie hundreds; thus, 1, 2, 3, *&c.* muſt be accounted 100, 200, 300, *&c.* miles, and conſequently 8 (in the ſame Column) muſt ſignifie eight hundred miles; and therefore ſeeing the Diſtance

Diſtance run conſiſts of 3 Figures (each Number in the Table conſiſting of 5) the difference of Latitude and Departure muſt each conſiſt of 3 Figures; then it is evident that in this Example the difference of Latitude is 665. 20, or 665 miles and 20 hundred parts of a mile, and the Departure 444.48 or 444 miles, and 48 hundred parts of a mile. Laſtly, If the diſtance run had been 8000 miles, the difference of Latitude would have been 6652 miles, and the Departure 4444.8 miles, or 4444 miles, and 8 tenths of a mile more.

EXAMPLE 5.

A Ship Sails SSE 74 *Miles. I demand her Difference of Latitude and Departure.*

In this Caſe you muſt break the diſtance run into two parts: Namely 70 and 4, then it is evident from Example 3*d.* that if the diſtance run be 70 miles the Diff. Latit. will be 64 miles and 672 thouſand parts of a mile, and that the Departure will be 26 miles and 788 thouſand parts of a mile. Again by Examp. 1, If the diſtance run be 4 miles, Diſt. Latit. will be 3 miles and 9232 ten Thouſand parts of a mile; alſo the Departure will then be 0 mile, and 7804 ten thouſand parts of a mile: But 64.672 miles added to 3.9232 miles make 68 miles, and 5952 ten thouſand parts of a mile for the difference of Latitude required; and 26.788 added to 0.7804 make 27 miles and 5684 ten thouſand parts of a mile for the Departure required. Therefore it is evident that the difference of Latitude in this Example is 68.5952 miles, or 68.$\frac{6}{10}$

mile

miles almoſt, and that the Departure is 27.5684 miles, or 27. $\frac{5}{10}$ miles, and ſomewhat more.

EXAMPLE 6.

A Ship Sails WSW 123 *Miles. I demand her Difference of Latitude and Departure.*

Here the diſtance run muſt be broke into 3 parts (becauſe it conſiſts of 3 places) namely 100. 20. and 3. then by Examp. 4. it appears that if the diſtance run be 100 miles, the diff. of Latit. will be 38.270 miles, and the Departure will be 92.390 miles. Alſo by Examp. 3. it is evident, that if the diſtance run be 20 miles, the diff. of Latit. will be 0.7.645 miles, and the Departure 18.478 miles. Laſtly from Examp. 1. it is apparent that if the Diſtance run be 3 miles, the difference of Latit. will be 1.1480 mile, and the Departure 2.7716 miles: Write down all theſe particular differences of Latit. and Depart. exactly under one another, as here you ſee them expreſt.

Diff. Lat.	Depart.
38.270	92.390
07.654	18.478
1.1480	2.7716
47.0720	113.6396

And

And thus it appears that the difference of Latitude is 47 miles and .0720 ten thousand parts of a mile, and the Departure is 113 miles and 6396 ten thousand parts of a mile.

The Use of the Table of Logarithms, and the Tables of Artificial Sines, Tangents and Secants.

1. IN the Table of Logarithms you find the round or absolute Numbers beginning at 1, and continued to 1000 are placed under the Letter N, and against each of these absolute numbers stands the responding Logarithm.

Thus the Logarithm of 8 is 090309. the Logarithm of 80 is 190309. and the Logarithm of 800 is 290309. So that these Logarithmical number differ only in the first Figure which is called the Characteristic. And thus may the Logarithm of any absolute number between 1 and 1000 be found by inspection.

2. *To find the Logarithm of any number greater than* 1000.

Here you must note, that the Characteristic of the Logarithm answering to the absolute number 10. the Characteristic of 10 is 1. of 100 is 2. of 1000 is 3. of 10000 is 4. of 100000 is 5. *&c.*

Then

Then let it be required to find the Logarithm of 87654. here the Characteristic will be 4. and consequently the Logarithm of 80000 is 490309. But because this Table is continued only to 1000. take the Logarithm of the first 3 Figures, *viz.* of 876. which is put to signifie 87600. and the Logarithm thereof is 494250. By the same Method find the Logarithm of 87700 which is 494300, Subtract 494250 from 494300 the remainer is 50. Also subtract 87600 from 87700, the remainer is 100. Then say

If 100 require 50, what shall 54 require.

$$\frac{50}{2700}$$

Answer 27, which added to 494250, the sum 494277 is the Logarithm answering to the absolute Number 87654. And thus may any other Logarithm be found answerable to any absolute Number exceeding 1000.

3. *To find the absolute Number answering to any given Logarithm.*

If the given Logarithm be found exactly in the Table, then the Figure or Figures in the Column N (which stand against this given Logarithm) gives the absolute number required.

But if the given Logarithm cannot be exactly found in the Table, seek for the nearest number which is less than the given Logarithm: then subtract this nearest less number from the given Logarithm, the remainer shall be the Numerator of the Fraction required, and the Denominator of that

that Fraction is the Tabular difference between the nearest less, and the nearest greater Logarithm.

Let it be required to find the absolute number to this given Logarithm 155754.

The nearest less in the Table is 155630, which is the Logarithm of 36, the diff. between the Logarithm given and that in the Table is 124. the Numerator.

The nearest greater in the Table is 156820, diff. between this and the nearest less is 1190, which is the Denominator required, therefore, the true or absolute number answering to the given Logarithm is $361\frac{124}{190}$.

The use of the Table of Artificial Signes, Tangents and Secants (which are no more than the Logarithms of the natural Sines Tangents and Secants) may be easily apprehended from the preceeding Rules.

To find how much Powder is sufficient both for Action and Proof of any Piece of Ordinance.

RULE.

MUltiply the weight of the Ball by the Calibers in the Circumference of the Breech, and for Proof multiply this Product by 8. for Service multiply the same by 6. this last Product divided by 96 gives the number of Pounds of Powder.

EX-

EXAMPLE.

Let there be an Iron Ball weighing 24 *l.* fit for a Gun whoſe Breech contains 9 Calibers or Diameters of the Bore in Circumference,

I demand the quantity of Powder fit for Proof and Action.

Ball 24 *l.*	24 *l.*
Calib. 9	9
216	216
8	6
96)1728(18 *l.* Proof	96)1296(13 *l.* ½
96	96 Service or Action.
768	336
768	288
	48

This Rule is Short, and eaſie to be remembred, nor is there any difficulty in the Operation. We have many Authors who ſpend much pains in the delivery of this Propoſition, to ſmall Purpoſe; here you have the Rule in a few words, uſe it, or thoſe delivered by others, and let your Experience commend it to you.

TO

To find the Tunnage of a Ship.

Multiply the length of the Keal, by the breadth of the Midſhip beam, and that Product by the depth of the Hold; Divide this number by 100, the Quotient gives the Tunnage for Men of War, and the ſame Product divided by 95 gives the Tunnage for Merchants Ships. A Rule ſo eaſy and plain needs no Example.

To find the Prime or Golden Number.

To the given Year of our Lord add 1. divide that Summ by 19, the remainer is the Prime required. If there be no remainer, then ſhall 19 be the Prime that Year.

To find the Epact.

Multiply the Prime for the given Year by 11. divide that Product by 30, the remainer ſhall be the Epact. If nothing remain the Epact is 30.

To find the Moon's Age,

Add the Epact, the number of the Months from *March*, and the day of the Month given incluſively, and if the Summ of theſe 3 numbers be leſs then 30, it ſhall be the Age of the Moon, if greater ſubtract 30 from it, and the remainer is the Age required.

EXAMPLE.

June 24. 1695., *I demand the Moon's Age.*

1695	5	Epact 25
1	11	day of the Month. 24
19)1696(89	3|5|5|1	Months from *March* 4
152	2|0	
		53
176	Spct. 25	30
171		
		Moon's Age 23
Prime. 5		

To find the hour of the Moon's Culminating or coming upon the Meridian.

Multiply the Moon's Age by 4. divide that Product by 5. the Quotient is the time of the Moon's Southing, or coming upon the Meridian.

Note that between the New and Full Moon she comes South in the Evening, but after the Full Moon, in the Morning.

The nearest Estimate of the Moon's Rising and Setting. At the New Moon she Riseth and Setteth with the Sun. At the Full, she Riseth when the Sun Setts, and Setts at Sun-Rise.

At the beginning of her Encrease she Riseth after-Sun Rise, and Setteth after Sun-Set.

At the beginning of her Decrease she Riseth a little after Sun-Sett, and Setts a little after Sun Rise.

At her first Quarter she Riseth about Noon and Setts about Midnight. Day

Lastly, She Riseth every $\frac{4}{5}$ of an hour later than she did the day before, which is the reason that you multiply her Age by 4, and divide that Product by 5 to find the time of her coming to the South.

To find the time of high Water.

To the Moon's Southing add the time of full Sea in that Place where you desire the time of high Water, and that sum shall be the Answer.

Thus at *London* when the Moon comes NE or SW (which answereth to 3 hours being 45°. from the Meridian) it is full Sea; to which add the time of the Moon's Southing, the Total is the time of high Water required.

He that desires to improve his Knowledg further in the use of the Calender may consult *Clavius* his Computum Ecclesiasticum. *De Chales* his Mundus Mathematicus. Dactylismum Ecclesiasticum Pomp. Lempei, and *Joannes Jocobus* in his Syn. Mathemat. where he will not only find the Rules, but the Reason of them explained.

FINIS.

A
TRIANGULAR CANON
Logarithmical:

OR A

TABLE

OF

Artificial SINES, TANGENTS, and SECANTS, the Radius 10, 00000 ; and to every Degree and Minute of the QUADRANT.

LONDON,
Printed by *J. Orme*, for *Christopher Hussey*, at the three *Flower-de-Luce's* in *Little Britain*, 1695.

0 Degrees.

M	Sine		Tang.		Secant.		
0	0.00000	10.0000	0.00000	Infinite.	10.00000	Infinite.	60
1	6.46372	9.99999	6.46372	13.53627	10.00000	13.53627	59
2	6.76475	9.99999	6.76475	13.23524	10.00000	13.23524	58
3	6.94084	9.99999	6.94084	13.05915	10.00000	13.05915	57
4	7.06578	9.99999	7.06578	12.93421	10.00000	12.93421	56
5	7.16269	9.99999	7.16269	12.83730	10.00000	12.83730	55
6	7.24187	9.99999	7.24187	12.75812	10.00000	12.75812	54
7	7.30882	9.99999	7.30882	12.69117	10.00000	12.69117	53
8	7.36681	9.99999	7.36681	12.63318	10.00000	12.63318	52
9	7.41796	9.99999	7.41797	12.58203	10.00000	12.58203	51
10	7.46372	9.99999	7.46372	12.53627	10.00000	12.53627	50
11	7.50511	9.99999	7.50512	12.49488	10.00000	12.49488	49
12	7.54290	9.99999	7.54290	12.45709	10.00000	12.45709	48
13	7.57766	9.99999	7.57767	12.42232	10.00000	12.42233	47
14	7.60985	9.99999	7.60985	12.39014	10.00000	12.39014	46
15	7.63981	9.99999	7.63982	12.36018	10.00000	12.36018	45
16	7.66784	9.99999	7.66784	12.33215	10.00000	12.33215	44
17	7.69417	9.99999	7.69417	12.30582	10.00000	12.30582	43
18	7.71899	9.99999	7.71900	12.28099	10.00000	12.28100	42
19	7.74247	9.99999	7.74248	12.25751	10.00000	12.25752	41
20	7.76475	9.99999	7.76476	12.23523	10.00000	12.23524	40
21	7.78594	9.99999	7.78595	12.21404	10.00000	12.21405	39
22	7.80614	9.99999	7.80615	12.19384	10.00000	12.19385	38
23	7.82545	9.99999	7.82546	12.17454	10.00001	12.17451	37
24	7.84393	9.99998	7.84394	12.15605	10.00001	12.15606	36
25	7.86166	9.99998	7.86167	12.13832	10.00001	12.13833	35
26	7.87869	9.99998	7.87870	12.12129	10.00001	12.12130	34
27	7.89508	9.99998	7.89509	12.10490	10.00001	12.10491	33
28	7.91087	9.99998	7.91089	12.08910	10.00001	12.08912	32
29	7.92611	9.99998	7.92613	12.07386	10.00001	12.07388	31
30	7.94084	9.99998	7.94085	12.05914	10.00001	12.05915	30
		Sine.		Tangent.		Secant.	M.

89 Degrees.

0 *Degrees.*

M.	Sine		Tang.		Secant.		
30	7.94084	9.99998	7.94085	12.05914	10.00001	12.05915	30
31	7.95508	9.99998	7.95510	12.04490	10.00001	12.04491	29
32	7.96887	9.99998	7.96888	12.03111	10.00001	12.03113	28
33	7.98223	9.99998	7.98225	12.01774	10.00002	12.01776	27
34	7.99519	9.99997	7.99521	12.00478	10.00002	12.00480	26
35	8.00778	9.99997	8.00780	11.99219	10.00002	11.99221	25
36	8.02002	9.99997	8.02004	11.97995	10.00002	11.97997	24
37	8.03191	9.99997	8.03194	11.96805	10.00002	11.96808	23
38	8.04350	9.99997	8.04352	11.95647	10.00002	11.95649	22
39	8.05478	9.99997	8.05480	11.94519	10.00002	11.94521	21
40	8.06577	9.99997	8.06580	11.93419	10.00002	11.93422	20
41	8.07650	9.99996	8.07653	11.92346	10.00003	11.92350	19
42	8.08696	9.99996	8.08699	11.91300	10.00003	11.91303	18
43	8.09718	9.99996	8.09721	11.90278	10.00003	11.90281	17
44	8.10716	9.99996	8.10720	11.89279	10.00003	11.89283	16
45	8.11692	9.99996	8.11696	11.88303	10.00003	11.88307	15
46	8.12647	9.99996	8.12651	11.87349	10.00003	11.87352	14
47	8.13581	9.99995	8.13585	11.86414	10.00004	11.86419	13
48	8.14495	9.99995	8.14499	11.85500	10.00004	11.85504	12
49	8.15390	9.99995	8.15395	11.84604	10.00004	11.84609	11
50	8.16268	9.99995	8.16272	11.83727	10.00004	11.83731	10
51	8.17128	9.99995	8.17132	11.82867	10.00004	11.82872	9
52	8.17971	9.99995	8.17976	11.82023	10.00004	11.82028	8
53	8.18798	9.99994	8.18803	11.81196	10.00005	11.81201	7
54	8.19610	9.99994	8.19615	11.80284	10.00005	11.80389	6
55	8.20407	9.99994	8.20412	11.79587	10.00005	11.79593	5
56	8.21189	9.99994	8.21195	11.78804	10.00005	11.78810	4
57	8.21958	9.99994	8.21964	11.78035	10.00006	11.78041	3
58	8.22713	9.99993	8.22719	11.77280	10.00006	11.77286	2
59	8.23455	9.99993	8.23462	11.76537	10.00006	11.76544	1
60	8.2418	9.99993	8.24192	11.75807	10.00006	11.75814	0
		Sine.	Tangent			Secant.	M

89 *Degrees.*

1 *Degrees.*

M	Sine		Tang.		Secant.		
0	8.24185	9.99993	8.24192	11.75807	10.00006	11.75814	60
1	8.24903	9.99993	8.24910	11.75089	10.00006	11.75096	59
2	8.2560	9.99992	8.25616	11.74383	10.00007	11.74390	58
3	8.26304	9.99992	8.26311	11.73688	10.00007	11.73695	57
4	8.26988	9.99992	8.26995	11.73004	10.00007	11.73011	56
5	8.27661	9.99992	8.27669	11.72330	10.00007	11.72338	55
6	8.2832	9.99992	8.28332	11.71667	10.00008	11.71675	54
7	8.28977	9.99991	8.28985	11.71014	10.00008	11.71022	53
8	8.29620	9.99991	8.29629	11.70370	10.00008	11.70379	52
9	8.30254	9.99991	8.30263	11.69736	10.00008	11.69745	51
10	8.30879	9.99991	8.30888	11.69111	10.00009	11.69120	50
11	8.31495	9.99990	8.31504	11.68495	10.00009	11.68504	49
12	8.32102	9.99990	8.32112	11.67887	10.00009	11.67897	48
13	8.32701	9.99990	8.32711	11.67288	10.00009	11.67298	47
14	8.32292	9.99989	8.33302	11.66697	10.00010	11.66707	46
15	8.33875	9.99989	8.3383	11.66114	10.00010	11.66124	45
16	8.34450	9.99989	8.34461	11.65538	10.00010	11.65549	44
17	8.35018	9.99989	8.35028	11.64971	10.00010	11.64981	43
18	8.35578	9.99988	8.35589	11.64410	10.00011	11.64421	42
19	8.36131	9.99988	8.36143	11.63857	10.00011	11.63868	41
20	8.36677	9.99988	8.36689	11.63310	10.00011	11.63322	40
21	8.37217	9.99987	8.37229	11.62770	10.00012	11.62782	39
22	8.37749	9.99987	8.37762	11.62237	10.00012	11.62250	38
23	8.38276	9.99987	8.38288	11.61711	10.00012	11.61723	37
24	8.38796	9.99987	8.38809	11.61190	10.00013	11.61203	36
25	8.39310	9.99986	8.39323	11.60676	10.00013	11.60689	3
26	8.39817	9.99986	8.39831	11.60168	10.00013	11.60182	3
27	8.40319	9.99986	8.40333	11.5966	10.00013	11.59680	3
28	8.40816	9.99985	8.40830	11.59169	10.00014	11.59183	3
29	8.41306	9.99985	8.41321	11.58678	10.00014	11.58693	3
30	8.41791	9.99985	8.41806	11.58193	10.00014	11.58208	3
		Sine		Tangent.		Secant.	M

88 *Degrees.*

1 Degrees.							
M.	Sine		Tang.		Secant.		
30	8.41791	9.9998	8.41806	11.58193	10.00014	11.58208	30
31	8.42271	9.99984	8.42286	11.5771[illegible]	10.00015	11.57728	29
32	8.42746	9.99984	8.42761	11.57238	10.00015	11.57253	28
33	8.4321[illegible]	9.9998	8.43231	11.56768	10.00015	11.56784	27
34	8.43680	9.99983	8.43695	11.5630[illegible]	10.00016	11.56320	26
35	8.44139	9.9998	8.44150	11.55844	10.00016	11.55860	25
36	8.44594	9.9998[illegible]	8.44611	11.55389	10.00016	11.55405	24
37	8.45044	9.99982	8.45061	11.54938	10.00017	11.54956	23
38	8.45489	9.99982	8.45507	11.54493	10.00017	11.54510	22
39	8.45930	9.99982	8.45948	11.54051	10.00018	11.54069	21
40	8.4[illegible]306	9.99981	8.46384	11.53615	10.00018	11.53633	20
41	8.46798	9.99981	8.46817	11.53182	10.00018	11.53201	19
42	8.47226	9.99980	8.47245	11.52754	10.00019	11.52773	18
43	8:47649	9.99980	8.47669	11.52330	10.00019	11.52350	17
44	8.48064	9.99980	8.48089	11.51910	10.00019	11.51930	16
45	8.4848[illegible]	9.99979	8.48505	11.51494	10.00020	11.51515	15
46	8.48896	9.99979	8.48917	11.51083	10.00020	11.51103	14
47	8.4930[illegible]	9.99979	8.49325	11.50675	10.00021	11.50696	13
48	8.49707	9.99978	8.49729	11.50270	10.00021	11.50292	12
49	8.50108	9.99978	8.50129	11.49870	10.00021	11.49892	11
50	8.50504	9.99977	8.50526	11.49473	10.00022	11.49495	10
51	8.50897	9.99977	8.50920	11.49080	10.00022	11.49102	9
52	8.51286	9.99976	8.51309	11.48690	10.00023	11.48713	8
53	8.51672	9.99976	8.51696	11.48303	10.00023	11.48327	7
54	8.52055	9.99976	8.52079	11.47921	10.00023	11.47944	6
55	8.52434	9.99975	8.52458	11.4754[illegible]	10.00024	11.47565	5
56	8.52810	9.99975	8.52834	11.47165	10.00024	11.47189	4
57	8.53182	9.99974	8.53208	11.46792	10.00025	11.46817	3
58	8.53552	9.99974	8.53577	11.46422	10.00025	11.46447	2
59	8.53918	9.99974	8.53944	11.46055	10.00026	11.46081	1
60	8.54281	9.99974	8.54308	11.45691	10.00026	11.45718	0
		Sine.		Tangent.		Secant.	M.
88 Degrees.							

2 *Degrees.*

M.	Sine.		Tang		Secant.	Tang.	
0	8.54281	9.99973	8.54308	11.45691	10. 0026	11.45718	60
1	8.54642	9.99973	8.54669	11.45330	10.00026	11.45357	59
2	8.54999	9.99972	8.55026	11.44973	10.00027	11.45000	58
3	8.55353	9.99972	8.55381	11.44618	10.00027	11.44646	57
4	8.55705	9.99971	8.55733	11.44266	10.00028	11.44294	56
5	8.56054	9.99971	8.56082	11.43617	10.00028	11.43946	55
6	8.56399	9.99970	8,56429	11.43570	10.00029	11.43600	54
7	8.56743	9.99970	8.56772	11.43227	10.00029	11.43256	53
8	8.57083	9.99969	8.57113	11.42886	10.00030	11.42916	52
9	8.57421	9.99969	8.57452	11.42548	10.00030	11.42578	51
10	8.57756	9.99968	8.57787	11.42212	10.00031	11.42243	50
11	8.58089	9.99968	8.58120	11.41879	10.00031	11.41910	49
12	8.58419	9.99968	8.58451	11.41548	10.00032	11.41580	48
13	8.58746	9.99967	8.58779	11.41220	10.00032	11.41253	47
14	8.59072	9.99967	8.59105	11.40894	10.00033	11.40927	46
15	8.59394	9.99966	8.59428	1.40571	10.00033	11.406 5	45
16	8.59715	9.99966	8.59749	11.40250	10.00034	11.40284	44
17	8.60033	9.99965	8.60067	11.39932	10.00034	11.39966	43
18	8.60348	9.99965	8.60383	11.39616	10.00035	11.3965	42
19	8.60662	9.99964	8.60697	11.39302	10.00035	11.39337	41
20	8.60973	9.99964	8.61009	11.38990	10.00036	11.39026	40
21	8.61282	9.99963	8.61318	11.38681	10.00036	11.38717	39
22	8.61589	9.99962	8.61626	11.38373	10.00037	11.38410	48
23	8.61893	9.99962	8.61931	11.38068	10.00037	11.38106	47
24	8.62196	9.99961	8.62234	11.37765	10.00038	11.37803	46
25	8.62496	9.99961	8.62535	11.37464	10.00038	11.37503	35
26	8.62794	9.99960	8.62834	11.37166	10.00039	11.37205	34
27	8.63091	9.99960	8.63130	11.36869	10 00039	11.36908	33
28	8.63385	9.99959	8.63425	11.36574	10.00 4	11.36614	32
29	8.63677	9.99959	8.63718	11.36281	10.00040	11.36322	31
30	8.63968	9.99958	8.64009	11.35990	10.00041	11.36032	30
		Sine.		Tang.		Secant.	

87 *Degrees.*

2 *Degrees.*

M.	Sine		Tang.		Secant		
30	8.63968	9.99958	3.64009	11.35990	10.00041	11.36032	30
31	8.64256	9.99958	8.64298	11.35701	10.00041	11.35743	29
32	8.64542	9.99957	3.64585	11.35414	10.00042	11.35457	28
33	8.64827	9.99957	3.64870	11.35129	10.00043	11.35172	27
34	8.6511	9.99956	3.65153	11.34846	10.00043	11.34889	26
35	8.65391	9.99955	3.65435	11.34564	10.00044	11.34608	25
36	8.65670	9.99955	3.65714	11.34285	10.00044	11.343[illegible]	[illegible]
37	8.65947	9.99954	3.65992	11.34007	10.00045	11.340[illegible]	23
38	3.66223	9.99954	3.66268	11.3373[illegible]	10.00045	11.33777	22
39	3.66496	9.99953	3.66543	11.33456	10.00046	11.335[illegible]	21
40	3.66768	9.99952	3.66816	11.33184	10.00047	11.33231	20
41	8.67039	9.99952	3.67087	11.3291[illegible]	10.00047	11.32960	19
42	3.67308	9.99951	3.67356	11.3264[illegible]	10.00048	11.32692	18
43	8.67575	9.99951	8.67623	11.32376	10.00048	11.32424	17
44	8.67840	9.99950	3.67890	11.32110	10.00049	11.32159	16
45	3.63104	9.9995[illegible]	3.68154	11.318[illegible]	10.00050	11.31895	15
46	3.63366	9.99949	3.63417	11.31582	10.00050	11.31633	14
47	3.68627	9.99948	3.63678	11.31321	10.00051	11.3137[illegible]	13
48	3.68886	9.99948	3.68938	11.3106[illegible]	10.00051	11.31113	12
49	3.69143	9.99947	3.69196	11.308[illegible]	10.00052	11.30856	11
50	3.69399	9.99946	3.69452	11.30547	10.00053	11.30600	10
51	3.69654	9.99946	3.69708	11.3029[illegible]	10.00053	11.3034[illegible]	9
52	3.69907	9.99945	3.69961	11.30038	10.00054	11.30092	[illegible]
53	3.70158	9.99945	3.70213	11.29786	10.00055	11.29841	[illegible]
54	3.70407	9.99944	3.70464	11.2953[illegible]	10.00055	11.29591	6
55	3.70657	9.99943	3.70713	11.29286	10.00056	11.29342	5
56	3.70904	9.99943	3.70961	11.29039	10.00056	11.29095	4
57	3.71150	9.99942	3.71208	11.28791	10.00057	11.2884[illegible]	[illegible]
[illegible]	3.71395	9.99941	3.71452	11.28546	10.00058	11.2860[illegible]	[illegible]
[illegible]	3.71638	9.99941	3.71697	11.28302	10.00058	11.28361	[illegible]
[illegible]	3.71880	9.99940	3.71939	11.28060	10.00059	11.28120	[illegible]
		Sine		Tang.		Secant	M.

87 *Degrees.*

3 *Degrees.*

M.	Sine.		Tang.		Secant		
0	8.71880	9.99940	8.71939	11.28060	10.00059	11.28120	60
1	8.72120	9.99039	8.72180	11.27819	10.00060	11.27879	59
2	8.72359	9.99939	8.72420	11.27579	10.00060	11.27640	58
3	8.72597	9.99938	8.72658	11.27341	10.00061	11.27402	57
4	8.72833	9.99937	8.72895	11.27104	10.00062	14 27166	56
5	8.73068	9.99937	8.73131	11.26868	10.00062	11.26931	55
6	8.73302	9.99936	8.73366	11.26633	10.00063	11.26697	54
7	8.73535	9.99935	8.73559	11.26400	10.00064	11.26464	53
8	8.73766	9.99935	8.73831	11.26168	10.00065	11.26233	52
9	8.73996	9.99934	8.74062	11.25937	10.00065	11.26003	51
10	8.74225	9.99933	8.74292	11.25707	10.00066	11.25774	50
11	8.74453	9.99932	8.74520	11.25479	10.00067	11.25546	49
12	8.74680	9.99932	8.74747	11.25252	10.00067	11.25319	48
13	8.74905	9.99931	8.74974	11.25026	10.00068	11.25094	47
14	8.75129	9.99930	8.75108	11.24801	10.00069	11.24870	46
15	8.75352	9.99930	8.75422	11.24577	10.00069	11.24647	45
16	8.75574	9.99929	8.75645	11.24354	10.00070	11.24425	44
17	8.75795	9.99928	8.75866	11.24133	10.00071	11.24204	43
18	8.76015	9.99927	8.76087	11.23912	10.00072	11.23984	42
19	8.76233	9.99927	8.76306	11.23693	10.00072	11.23766	41
20	8.76451	9.99926	8.76524	11.23475	10.00073	11.23548	40
21	8.76667	9.99925	8.76741	11.23258	10.00074	11.23332	39
22	8.76882	9.99925	8.76957	11.23042	10.00075	11.23117	38
23	8.77097	9.99924	8.77172	11.22827	10.00075	11.22903	37
24	8.7731[illegible]	[illegible].9902[illegible]	8.77386	11.22613	10.00076	11.22689	36
25	8.77522	9.99922	8.77599	11.22400	10.00077	11.22477	35
26	8.77733	9.99922	8.77811	11.22188	10.00078	11.22266	34
27	8.77943	9.99921	8.78022	11.21977	10.00078	11.22056	33
28	8.78152	9.99920	8.78232	11.21768	10.00079	11.21847	32
29	8.78360	[illegible].99916	8.78446	11.21559	10.00080	11.21639	31
30	8.7[illegible]567	9.99918	8.78648	11.21351	10.00081	11.21432	30
		Sine		Tang.		Secant.	M.

86 *Degrees.*

3 *Degrees.*

M.	Sine.		Tang		Secant.	Tang.	
30	8.78567	9.99918	8.78648	11.21351	10.00081	11.21432	30
31	8.78773	9.99918	8.78855	11.21144	10.00081	11.21226	29
32	8.78978	9.99917	8.79061	11.20938	10.00082	11.21021	28
33	8.79182	9.99916	8.79266	11.20733	10.00083	11.20817	27
34	8.79385	9.99915	8.79470	11.20529	10.00084	11.20614	26
35	8.79588	9.99915	8.79673	11.20326	10.00085	11.20411	25
36	8.79789	9.99914	8.79875	11.20124	10.00085	11.20210	24
37	8.79989	9.99913	8.80076	11.19923	10.00086	11.20010	23
38	8.80189	9.99912	8.80276	11.19723	10.00087	11.19810	22
39	8.80387	9.99911	8.80475	11.19524	10.00088	11.19612	21
40	8.80585	9.99911	8.80674	11.19325	10.00089	11.19414	20
41	8.80781	9.99910	8.80871	11.19128	10.00089	11.19218	19
42	8.80977	9.99909	8.81068	11.18931	10.00090	11.19022	18
43	8.81172	9.99908	8.81264	11.18735	10.00091	11.18827	17
44	8.81366	9.99907	8.81458	11.18541	10.00092	11.18632	16
45	8.81559	9.99906	8.81652	11.18347	10.00093	11.18440	15
46	8.81752	9.99906	8.81846	11.18153	10.00093	11.18247	14
47	8.81943	9.99905	8.82038	11.17961	10.00094	11.18056	13
48	8.82134	9.99904	8.82229	11.17770	10.00095	11.17865	12
49	8.82324	9.99903	8.82420	11.17579	10.00096	11.17676	11
50	8.82513	9.99902	8.82610	11.17389	10.00097	11.17437	10
51	8.82701	9.99901	8.82799	11.172[illegible]	10.00099	11.17298	9
52	8.82888	9.99901	8.82987	11.17012	10.00099	11.17111	8
53	8.83074	9.99900	8.83174	11.16825	10.00099	11.16925	7
54	8.83260	9.99899	8.83361	11.16638	10.00100	11.16739	6
55	8.83445	9.99898	8.83547	11.16452	10.00101	11.16554	5
56	8.83629	9.99897	8.83732	11.16267	10.00102	11.16370	4
57	8.83813	9.99896	8.83916	11.1[illegible]83	10.00103	11.16187	3
58	8.83995	9.99895	8.84099	11.15900	10.00104	11.16004	2
59	8.84177	9.99895	8.84282	11.15717	10.00105	11.15822	1
60	8.84358	9.99894	8.84464	11.15535	10.00105	11.15641	0
		Sine.	Tang.			Secant.	M.

86 *Degrees.*

4 Degrees.							
M.	Sine		Tang.		Secant		
0	8.84358	9.99894	8.84464	11.15535	10.00105	11.15641	60
1	8.84538	9.99893	8.84645	11.15354	10.00106	11.15461	59
2	8.84718	9.99892	8.84826	11.15174	10.00107	11.15281	58
3	8.84897	9.99891	8.85005	11.14994	10.00108	11.15102	57
4	8.85075	9.96890	8.85184	11.14815	10.0010[illegible]	11.14924	56
5	8.8525[illegible]	9.99889	8.85362	11.14637	10.00110	11.14747	55
6	8.85425	9.99888	8.85540	11.14459	10.00111	11.1457[illegible]	54
7	8.85604	9.99887	8.85717	11.14282	10.00112	11.14395	53
8	8.85780	9.99886	8.85893	11.14106	10.00113	11.14219	52
9	8.85994	9.96886	8.86068	11.13931	10.00114	11.14055	51
10	8.8612[illegible]	9.99885	8.86243	11.13756	10.00114	11.1387[illegible]	50
11	8.86301	9.99884	8.86417	11.13582	10.00115	11.136[illegible]	49
12	8.8647[illegible]	9.99883	8.86590	11.13409	10.00116	11.13526	48
13	8.8664[illegible]	9.99882	8.86763	11.13236	10.00117	11.13354	47
14	8.86816	9.99881	8.86935	11.13064	10.00118	11.13183	46
15	8.86986	9.99880	8.87106	11.12893	10.00119	11.13013	45
16	8.87156	9.99879	8.87277	11.12723	10.00120	11.1284[illegible]	44
17	8.87325	9.99878	8.87446	11.12553	10.00121	11.12674	43
18	8.87493	9.99877	8.87616	11.12383	10.00122	11.12506	42
19	8.87661	9.99876	8.87784	11.12215	10.00123	11.12338	41
20	8.87828	9.99875	8.87952	11.12047	10.00124	11.12171	40
21	8.87994	9.99874	8.88129	11.11879	10.00125	11.12005	39
22	8.8816[illegible]	.99873	8.88286	11.11713	10.00126	11.1183[illegible]	38
23	8.88325	9.99872	8.88453	11.11547	10.00127	11.1167[illegible]	37
24	8.88490	9.98871	8.88618	11.11381	10.00128	11.115[illegible]	36
25	8.88654	9.59870	8.88783	11.11216	10.00129	11.11345	35
26	8.88817	9.9986[illegible]	8.88947	11.11052	10.00130	11.1118[illegible]	34
27	8.88 80	9.99868	8.89111	11.10888	10.00131	11.110[illegible]	33
28	8.80142	9.99867	8.8927[illegible]	11.10725	10.00132	11.10857	32
29	8.89303	9.99866	8.89436	11.10563	10.00133	11.10696	31
30	8.8[illegible]464	9.99865	8.8[illegible]598	11.10401	10.00134	11.10535	30
		Sine		Tang.		Secant	M.
85 Degrees.							

4. *Degrees.*

M.	Sine.		Tang.		Secant		
30	8.89464	9.99865	8.89598	11.10401	10.00134	11.10535	30
31	8.89624	9.99864	8.89759	11.10240	10.00135	11.10375	29
32	8.89784	9.99863	8.89920	11.10079	10.00136	11.10215	28
33	8.89943	9.99862	8.90080	11.09919	10.00137	11.10056	27
34	8.90101	9.99861	8.90235	11.09760	10.00138	11.09898	26
35	8.90259	9.99860	8.90398	11.09601	10.00139	11.09740	25
36	8.90416	9.96859	8.90557	11.09443	10.00140	11.09583	24
37	8.90573	9.99858	8.90714	11.09285	10.00140	11.09426	23
38	8.90729	9.99857	8.90871	11.09128	10.00142	11.09270	22
39	8.90885	9.99856	8.91028	11.08971	10.00143	11.09114	21
40	8.91040	9.99855	8.91184	11.08815	10.00144	11.08959	20
41	8.91194	9.95854	8.91340	11.08659	10.00145	11.08805	19
42	8.91348	9.99853	8.91495	11.08504	10.00146	11.08651	18
43	8.91502	9.99852	8.91649	11.08350	10.00147	11.08497	17
44	8.91655	9.99851	8.91803	11.08196	10.00148	11.08345	16
45	8.91807	9.99850	8.91956	11.08043	10.00149	11.08192	15
46	8.91959	9.99849	8.92109	11.07890	10.00150	11.08040	14
47	8.92110	9.99848	8.92261	11.07738	10.00151	11.07889	13
48	8.92261	9.99847	8.92413	11.07586	10.00152	11.07738	12
49	8.92411	9.99846	8.92564	11.07435	10.00153	11.07588	11
50	8.92560	9.99845	8.92715	11.07285	10.00154	11.07439	10
51	8.92710	9.99844	8.92865	11.07134	10.00155	11.07290	9
52	8.92858	9.99843	8.93015	11.06984	10.00156	11.07141	8
53	8.93006	9.99842	8.93164	11.06835	10.00157	11.06993	7
54	8.93154	9.99841	8.93313	11.06686	10.00159	11.06845	6
55	8.93301	9.99839	8.93461	11.06538	10.00160	11.06698	5
56	8.93448	9.99838	8.93609	11.06390	10.00161	11.06551	4
57	8.93594	9.99837	8.93756	11.06243	10.00162	11.06405	3
58	8.93739	9.99836	8.93903	11.06096	10.00163	11.06260	2
59	8.93885	9.99835	8.94049	11.05950	10.00164	11.06115	1
60	8.94029	9.99834	8.94195	11.05804	10.00165	11.05970	0
		Sine		Tang.		Secant	M

83. *Degrees.*

5. *Degrees.*

M.	Sine.		Tang.		Secant		
0	8.94029	9.99834	8.94195	11.05804	10.00165	11.05970	60
1	8.94173	9.99833	8.94340	11.05659	10.00166	11.05826	59
2	8.94317	9.99832	8.94485	11.05514	10.00167	11.05682	58
3	8.94460	9.99831	8.94629	11.05370	10.00168	11.05539	57
4	8.94603	9.99830	8.94773	11.05226	10.00170	11.05396	56
5	8.94745	9.99828	8.94916	11.05083	10.00171	11.05254	55
6	8.94887	9.96827	8.95059	11.04940	10.00172	11.05112	54
7	8.95028	9.99826	8.95202	11.04797	10.00173	11.04971	53
8	8.95169	9.99825	8.95344	11.04655	10.00174	11.04830	52
9	8.95310	9.99824	8.95485	11.04514	10.00175	11.04690	51
10	8.95449	9.99823	8.95626	11.04373	10.00176	11.04550	50
11	8.95589	9.99822	8.95767	11.04232	10.00178	11.04410	49
12	8.95728	9.99820	8.95907	11.04092	10.00179	11.04271	48
13	8.95867	9.99819	8.96047	11.03952	10.00180	11.04133	47
14	8.96005	9.99818	8.96186	11.03813	10.00181	11.03994	46
15	8.96142	9.99817	8.96325	11.03674	10.00182	11.03857	45
16	8.96280	9.99816	8.96463	11.03536	10.00183	11.03719	44
17	8.96417	9.99815	8.96601	11.03398	10.00184	11.03583	43
18	8.96553	9.99813	8.96739	11.03260	10.00186	11.03446	42
19	8.96689	9.99812	8.96876	11.03123	10.00187	11.03310	41
20	8.96824	9.99811	8.97013	11.02986	10.00188	11.03175	40
21	8.96960	9.99810	8.97149	11.02850	10.00189	11.03040	39
22	8.97094	9.99809	8.97285	11.02714	10.00190	11.02905	48
23	8.97228	9.99808	8.97420	11.02579	10.00192	11.02771	47
24	8.97362	9.99806	8.97556	11.02444	10.00193	11.02637	46
25	8.97496	9.99805	8.97690	11.02309	10.00194	11.02503	35
26	8.97629	9.99804	8.97824	11.02175	10.00195	11.02370	34
27	8.97761	9.99803	8.97958	11.01041	10.00196	11.02238	33
28	8.97894	9.99802	8.98092	11.01907	10.00198	11.02105	32
29	8.98025	9.99800	8.98225	11.01774	10.00199	11.01974	31
30	8.98157	9.99709	8.98357	11.01642	[illegible]	11.01842	30
		Sine		Tang.		Secant	

84. *Degrees.*

5 *Degrees.*

M.	Sine		Tang.		Secant		
30	8.98157	9.99799	8.98357	11.01642	10.00200	11.01842	30
31	8.98288	9.99798	8.98489	11.01510	10.00201	11.01712	29
32	8.98418	9.99797	8.98621	11.01378	10.00202	11.01582	28
33	8.98549	9.99795	8.98753	11.01246	10.00204	11.01451	27
34	8.98678	9.99794	8.98884	11.01115	10.00205	11.01322	26
35	8.98808	9.99793	8.99014	11.00985	10.00206	11.01192	25
36	8.98937	9.99792	8.99145	11.00854	10.00207	11.01062	24
37	8.99066	9.99791	8.99275	11.00725	10.00209	11.00934	23
38	8.99194	9.99789	8.99404	11.00595	10.00210	11.00805	22
39	8.99322	9.99788	8.99533	11.00466	10.00211	11.00678	21
40	8.99449	9.99787	8.99662	11.00337	10.00212	11.00550	20
41	8.99576	9.99785	8.99790	11.00209	10.00214	11.00423	19
42	8.99703	9.99784	8.99918	11.00081	10.00215	11.00296	18
43	8.99829	9.99783	8.00046	10.99953	10.00216	11.00170	17
44	8.99955	9.99782	8.00173	10.99826	10.00217	11.00044	16
45	9.00081	9.99780	9.00300	10.99699	10.00219	10.99918	15
46	9.00206	9.99779	9.00427	10.99572	10.00220	10.99794	14
47	9.00331	9.99778	9.00553	10.99446	10.00221	10.99668	13
48	9.00456	9.99777	9.00679	10.99320	10.00222	10.99543	12
49	9.00580	9.99775	9.00804	10.99195	10.00224	10.99419	11
50	9.00704	9.99774	9.00929	10.99070	10.00225	10.99296	10
51	9.00827	9.99773	9.01054	10.98945	10.00226	10.99173	9
52	9.00951	9.99771	9.01179	10.98821	10.00228	10.99049	8
53	9.01073	9.99770	9.01303	10.98696	10.00229	10.98926	7
54	9.01196	9.99769	9.01426	10.98573	10.00230	10.98804	6
55	9.01318	9.99768	9.01550	10.98449	10.00232	10.98681	5
56	9.01440	9.99766	9.01673	10.98326	10.00233	10.98560	4
57	9.01561	9.99765	9.01795	10.98204	10.00234	10.98438	3
58	9.01682	9.99764	9.01918	10.98081	10.00235	10.98317	2
59	9.01803	9.99762	9.02040	10.97959	10.00237	10.98196	1
60	9.01923	9.99761	9.02162	10.97828	10.00238	10.98077	0
		Sine		Tang.		Secant	M.

84 *Degrees.*

6. *Degrees.*

M	Sine		Tang.		Secant		
0	9.01923	9.99761	9.02162	10.97838	10.00238	10.98076	60
1	9.02043	9.99760	9.02283	10.97716	10.00239	10.97956	59
2	9.02163	9.99758	9.02404	10.97595	10.00241	10.97836	58
3	9.02282	9.99757	9.02525	10.97474	10.00242	10.97717	57
4	9.02401	9.99756	9.02645	10.97354	10.00243	10.97598	56
5	9.02520	9.99754	9.02765	10.97234	10.00245	10.97479	55
6	9.02638	9.99753	9.02885	10.97114	10.00246	10.97361	54
7	9.02756	9.99752	9.03004	10.96995	10.00247	10.97243	53
8	9.02874	9.99750	9.03123	10.96876	10.00249	10.97125	52
9	9.02991	9.99749	9.03242	10.96757	10.00250	10.97008	51
10	9.03108	9.99748	9.03360	10.96639	10.00252	10.96891	50
11	9.03225	9.99746	9.03479	10.96520	10.00253	10.96774	49
12	9.03342	9.99745	9.03596	10.96403	10.00254	10.96657	48
13	9.03458	9.99743	9.03714	10.96285	10.00256	10.96541	47
14	9.03574	9.99742	9.03831	10.96168	10.00257	10.96425	46
15	9.03689	9.99741	9.03948	10.96051	10.00258	10.96310	45
16	9.03804	9.99739	9.04065	10.95934	10.00260	10.96195	44
17	9.03919	9.99738	9.04181	10.95818	10.00261	10.96080	43
18	9.04034	9.99736	9.04297	10.95702	10.00263	10.95965	42
19	9.04148	9.99735	9.04413	10.9558[illegible]	0.00264	10.95851	41
20	9.04262	9.9973[illegible]	9.04528	10.9547[illegible]	10.00265	10.9573[illegible]	40
21	9.04376	9.99732	9.04643	10.95356	10.00266	10.95623	39
22	9.04489	9.99731	9.04758	10.95241	10.00268	10.95510	38
23	9.04602	9.99729	9.04872	10.95127	10.00270	10.95397	37
24	9.04715	9.99728	9.04986	10.95013	10.00271	10.95284	36
25	9.04827	9.99727	9.[illegible]510[illegible]	0.94899	10.00272	10.95172	35
26	9.04940	9.99725	9.05214	10.94785	10.00274	10.95059	34
27	9.05051	9.99724	9.05327	10.94672	10.00275	10.94948	33
28	9.05163	9.99722	9.05440	10.94559	10.00277	10.94836	32
29	9.05274	9.99721	9.05553	10.94446	10.00278	10.94725	31
30	9.05385	9.99719	9.05665	10.94334	10.00280	10.94614	30
		Sine		Tang		Secant	M

83. *Degrees.*

6 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.05385	9.99719	9.05665	10.94334	10.00280	10.94614	30
31	9.05496	9.99718	9.05778	10.94221	10.00281	10.94503	29
32	9.05607	9.99717	9.05890	10.94110	10.00283	10.94392	28
33	9.05717	9.99715	9.06001	10.93998	10.00284	10.94283	27
34	9.05827	9.99714	9.06113	10.93887	10.00285	10.94172	26
35	9.05936	9.99712	9.06224	10.93776	10.00287	10.94063	25
36	9.06046	9.99711	9.06334	10.93665	10.00288	10.93954	24
37	9.06155	9.99709	9.06445	10.93554	10.00290	10.93844	23
38	9.06263	9.99708	9.06555	10.93444	10.00291	10.93736	22
39	9.06372	9.99706	9.06665	10.93334	10.00293	10.93627	21
40	9.06480	9.99705	9.06775	10.93224	10.00294	10.93519	20
41	9.06588	9.99703	9.06884	10.93115	10.00296	10.93411	19
42	9.06596	9.99702	9.06993	10.93006	10.00297	10.93303	18
43	9.06803	9.99700	9.07102	10.92897	10.00299	10.93196	17
44	9.06910	9.99699	9.07211	10.92788	10.00300	10.93089	16
45	9.07017	9.99697	9.07319	10.92680	10.00302	10.92982	15
46	9.07124	9.99696	9.07427	10.92572	10.00303	10.92875	14
47	9.07230	9.99694	9.07535	10.92464	10.00305	10.92769	13
48	9.07336	9.99693	9.07643	10.92356	10.00306	10.92663	12
49	9.07442	9.99691	9.07750	10.92245	10.00308	10.92557	11
50	9.07548	9.99690	9.07857	10.92142	10.00309	10.92452	10
51	9.07653	9.99688	9.07964	10.92035	10.00311	10.92346	9
52	9.07758	9.99687	9.08071	10.91929	10.00312	10.92241	8
53	9.07863	9.99685	9.08177	10.91822	10.00314	10.92136	7
54	9.07967	9.99684	9.08283	10.91716	10.00315	10.92032	6
55	9.08071	9.99682	9.08389	10.91611	10.00317	10.91928	5
56	9.08175	9.99681	9.08494	10.91505	10.00318	16.91824	4
57	9.08279	9.99679	9.08600	10.91400	10.0032	10.91720	3
58	9.08383	9.99678	9.08705	10.91295	10.00321	10.91610	2
59	9.08486	9.99676	9.08809	10.91199	10.00323	10.91513	1
60	9.08589	9.99675	9.08914	10.91085	10.00324	10.91411	0
		Sine		Tang.			M.

83 *Degrees.*

7. *Degrees.*

M.	Sine		Tang.		Secant		
0	90.8589	9.99675	9.08914	10.91085	10.00324	10.91410	60
1	9.08692	9.99673	9.09018	10.90981	10.00326	10.91307	59
2	9.08794	9.99672	9.09122	10.90877	10.00328	10.91205	58
3	9.08897	9.99670	9.09226	10.90733	10.00329	10.91103	57
4	9.08999	9.99668	9.09330	10.90669	10.00331	10.91001	56
5	9.09100	9.99667	9.09433	10.90566	10.00332	10.90899	55
6	9.09202	9.99665	9.09536	10.90463	10.00334	10.90797	54
7	9.09303	9.99664	9.09639	10.90360	10.00335	10.90696	53
8	9.09404	9.99662	9.09742	10.90257	10.00337	10.90595	52
9	9.09505	9.99661	9.09844	10.90155	10.00339	10.90494	51
10	9.09606	9.99659	9.09946	10.90053	10.00340	10.90393	50
11	9.09706	9.99657	9.10048	10.89951	10.00342	10.90293	49
12	9.09806	9.99656	9.10150	10.89849	10.00343	10.90193	48
13	9.09906	9.99654	9.10251	10.89748	10.00345	10.90093	47
14	9.10006	9.99653	9.10353	10.89646	10.00347	10.89993	46
15	9.10105	9.99651	9.10454	10.89545	10.00348	10.89894	45
16	9.10204	9.99649	9.10555	10.89445	10.00350	10.89795	44
17	9.10303	9.99648	9.10655	10.89344	10.00351	10.89696	43
18	9.10402	9.99646	9.10755	10.89244	10.00353	10.89597	42
19	9.10501	9.99644	9.10856	10.89144	10.00355	10.89499	41
20	9.10599	9.99643	9.10955	10.89044	10.00356	10.89400	40
21	9.10697	9.99641	9.11055	10.88944	10.00358	10.89302	39
22	9.10795	9.99640	9.11155	10.88844	10.00360	10.89204	38
23	9.10892	9.99638	9.11254	10.88745	10.00361	10.89107	37
24	9.10990	9.99636	9.11353	10.88646	10.00363	10.89009	36
25	9.11087	9.99635	9.11452	10.88547	10.00364	10.88912	35
26	9.11184	9.99633	9.11550	10.88449	10.00366	10.88815	34
27	9.11280	9.99631	9.11649	10.88350	10.00368	10.88719	33
28	9.11377	9.99630	9.11747	10.88252	10.00369	10.88622	32
29	9.11473	9.99628	9.11845	10.88154	10.00371	10.88526	31
30	9.11569	9.99626	9.11942	10.88057	10.00373	10.88430	30
		Sine		Tang.		Secant	M.

82. *Degrees.*

7 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.11569	9.99626	9.11942	10.88057	10.00373	10.88430	30
31	9.11665	9.99625	9.12040	10.87959	10.00374	10.88334	29
32	9.11761	9.99623	9.12137	10.87862	10.00376	10.88238	28
33	9.11856	9.99621	9.12234	10.87765	10.00378	10.88143	27
34	9.11961	9.99620	9.12333	10.87668	10.00379	10.88048	26
35	9.12046	9.99618	9.12428	10.87571	10.00381	10.87953	25
36	9.12141	9.99616	9.12524	10.87475	10.00383	10.87858	24
37	9.12236	9.99615	9.12620	10.87378	10.00384	10.87763	23
38	9.12330	9.99613	9.12717	10.87282	10.00386	10.87669	22
39	9.12424	9.99611	9.12813	10.8718[illegible]	10.00388	10.87575	21
40	9.12518	9.99610	9.12908	10.87091	10.00390	10.87481	20
41	9.12612	9.99608	9.13004	10.86995	10.00391	10.87387	19
42	9.12706	9.99606	9.13099	10.86900	10.00393	10.87294	18
43	9.12799	9.99600	9.13194	10.86805	10.00395	10.87200	17
44	9.12892	9.99607	9.13289	10.86710	10.00396	10.87107	16
45	9.12985	9.99601	9.13383	10.86610	10.00398	10.87014	15
46	9.13078	9.99599	9.13478	10.86521	10.00400	10.86921	14
47	9.13170	9.99598	9.13572	10.86427	10.00402	10.86829	13
48	9.13263	9.99596	9.13666	10.86333	10.00403	10.86737	12
49	9.13355	9.99594	9.13760	10.86239	10.00405	10.86644	11
50	9.13447	9.99592	9.13854	10.8614[illegible]	10.00407	10.86553	10
51	9.13538	9.99591	9.13947	10.86052	10.00408	10.86461	9
52	9.1363	9.99589	9.14[illegible]40	10.85959	10.00410	10.86369	8
53	9.13721	9.99587	9.14134	10.85869	10.00412	10.86278	7
54	9.13812	9.99585	9.14226	10.8577[illegible]	0.00414	10.86187	6
55	9.13903	9.99584	9.14319	10.8568	10.00415	10.86[illegible]96	5
56	9.13994	9.99582	9.14412	10.85587	10.00417	10.86005	4
57	9.14085	9.99580	9.14504	10.85495	10.00419	10.85915	3
58	9.14175	9.99578	9.14596	10.85403	10.00421	10.85824	2
59	9.14265	9.99577	9.14688	10.85311	10.00422	10.85734	1
60	9.14355	9.99575	9.14780	10.85219	10.00424	10.85644	0
		Sine		Tang.		Secant	M

82 *Degrees.*

8 *Degrees.*

M	Sine		Tang.		Secant		
0	9.14355	9.99575	9.14780	10.85219	10.00424	10.85044	60
1	9.14445	9.99573	9.14871	10.85128	10.00425	10.85554	59
2	9.14534	9.99571	9.14963	10.85326	10.00428	10.85465	58
3	9.14624	9.99569	9.15054	10.84945	10.0043	10.85375	57
4	9.14713	9.99568	9.15145	10.84854	10.00431	10.85286	56
5	9.14802	9.99566	9.15236	10.84763	10.00433	10.85197	55
6	9.14891	9.99564	9.15326	10.84673	10.00435	10.85108	54
7	9.14980	9.99562	9.15417	10.84582	10.00437	10.85019	53
8	9.15068	9.99560	9.15507	10.84492	10.00439	10.84931	52
9	9.15156	9.90559	9.15597	10.84402	10.00440	10.84843	51
10	9.15245	9.99557	9.15088	10.84312	10.00442	10.84754	50
11	9.15333	9.99555	9.15777	10.84222	10.00444	10.84667	49
12	9.15420	9.99553	9.15867	10.84132	10.00446	10.84579	48
13	9.15508	9.99551	9.15956	10.84043	10.00448	10.84491	47
14	9.15595	9.99550	9.16046	10.83954	10.00449	10.84404	46
15	9.15683	9.99548	9.16134	10.83865	10.00451	10.84317	45
16	9.15770	9.99546	9.16223	10.83776	10.00453	10.84230	44
17	9.15856	9.99544	9.16312	10.83686	10.00455	10.84143	43
18	9.15943	9.99543	9.16400	10.83599	10.00457	10.84056	42
19	9.16030	9.99541	9.16489	10.83510	10.00459	10.83969	41
20	9.16116	9.99539	9.10577	10.83422	10.00401	10.83883	40
21	9.16202	9.99537	9.16665	10.83334	10.00462	10.83797	39
22	9.16288	9.99535	9.16753	10.83245	10.00464	10.83711	38
23	9.16374	9.99533	9.16849	10.83159	10.00466	10.8362[illegible]	37
24	9.16460	9.99531	9.16928	10.82071	10.00468	10.83540	36
25	9.16545	9.99529	9.17015	10.82984	10.0047	10.83454	3
26	9.16630	9.99527	9.17102	10.82897	10.00472	10.83369	3
27	9.16715	9.99526	9.17189	10.8281[illegible]	10.00474	10.83284	3
28	9.16800	9.99524	9.17276	10.82723	10.00475	10.83195	3
29	9.16885	9.99522	9.1736[illegible]	10.82636	10.00477	10.83114	3
30	9.16970	9.99520	9.1744[illegible]	10.82550	10.0047[illegible]	10.83025	3
	Sine	Sine		Tang.		Secant.	M

81 *Degrees.*

8 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.16970	9.99520	9.17449	10.82550	10.00479	10.83029	30
31	9.17054	9.99518	9.17536	10.82464	10.00481	10.82945	29
32	9.17138	9.99516	9.17622	10.82377	10.00483	10.82861	28
33	9.17223	9.99514	9.17708	10.82291	10.00485	10.82776	27
34	9.17307	9.99512	9.17794	10.82206	10.00489	10.82693	26
35	9.17390	9.99510	9.17879	10.82120	10.00489	10.82609	25
36	9.17474	9.99508	9.17965	10.8203[illegible]	10.00491	10.82525	24
37	9.17557	9.99507	9.18050	10.81949	10.00493	10.82442	23
38	9.17641	9.99505	9.18136	10.81864	10.00494	10.82358	22
39	9.17724	9.99503	9.18221	10.81778	10.00496	10.82275	21
40	9.17807	9.99501	9.18305	10.81694	10.00498	10.82192	20
41	9.17890	9.99499	9.18390	10.81609	10.00500	10.82110	19
42	9.17972	9.99497	9.18475	10.81524	10.00502	10.82027	18
43	9.18055	9.99495	9.18559	10.8144	10.00504	10.81948	17
44	9.18137	9.99493	9.18643	10.81356	10.00506	10.81862	16
45	9.18219	9.99491	9.18728	10.81271	10.00508	10.81780	15
46	9.18301	9.99489	9.18812	10.81188	10.00510	10.81698	14
47	9.18383	9.99487	9.18295	10.81104	10.00512	10.81618	13
48	9.18465	9.9948[illegible]	9.18979	10.81020	10.00514	10.81534	12
49	9.18546	9.99483	9.19062	10.80937	10.00516	10.81453	11
50	9.18628	9.99481	9.19146	10.80853	10.00518	10.81372	10
51	9.18709	9.99479	9.19229	10.8077[illegible]	10.00521	10.81290	9
52	9.18790	9.99477	9.19312	10.80687	10.00522	10.81209	8
53	9.18871	9.9947[illegible]	9.19395	10.80604	10.00524	10.81128	7
54	9.18951	9.99473	9.19478	10.80522	10.00526	10.81048	6
55	9.19032	9.99471	9.19560	10.8043[illegible]	10.00528	10.80967	5
56	9.19113	9.99470	9.19643	10.80357	10.00530	10.80887	4
57	9.19193	9.99468	9.197[illegible]	10.80274	10.00532	10.80806	3
58	9.19273	9.99466	9.19807	10.80192	10.00534	10.80726	2
59	9.19353	9.99464	9.19889	10.80110	10.00536	10.80646	1
60	9.1[illegible]422	9.99462	9.19971	10.8[illegible]	10.00538	10.80566	0
		Sine		Tang		Secant	M

81 *Degrees.*

9. *Degrees.*							
M	Sine.		Tang.		Secant		
0	9.19433	9.99462	9.19971	10.80029	10.00538	10.80566	60
1	9.19512	9.99460	9.20052	10.79947	10.00540	10.80487	59
2	9.19592	9.99458	9.20134	10.79865	10.00542	10.80407	58
3	9.19671	9.99456	9.20215	10.79784	10.00544	10.80328	57
4	9.19751	9.99454	9.20297	10.79702	10.00546	10.80248	56
5	9.19830	9.99451	9.20378	10.79621	10.00548	10.80169	55
6	9.19909	9.99449	9.20459	10.79540	10.00550	10.80090	54
7	9.19987	9.99447	9.20540	10.79460	10.00552	10.80012	53
8	9.20066	9.99445	9.20620	10.79379	10.00554	10.79933	52
9	9.20145	9.99443	9.20701	10.79298	10.00556	10.79854	51
10	9.20223	9.99441	9.2078	10.79218	10.00558	10.79776	50
11	9.20301	9.99439	9.2086[illegible]	10.79138	10.00560	10.79698	49
12	9.20379	9.99437	9.20942	10.79058	10.00562	10.79620	48
13	9.20457	9.99435	9.21022	10.78978	10.00564	10.79542	47
14	9.20535	9.99433	9.21101	10.78898	10.00566	10.79464	46
15	9.20613	9.99431	9.21181	10.78818	10.00568	10.79386	45
16	9.20690	9.99429	9.21261	10.78738	10.00570	10.79309	44
17	9.20767	9.99427	9.21340	10.78659	10.00572	10.79232	43
18	9.20845	9.99425	9.21419	10.78580	10.00574	10.79154	42
19	9.20922	9.99423	9.21498	10.78501	10.00576	10.79077	41
20	9.20999	9.99421	9.21577	10.78422	10.00578	10.79000	40
21	9.21076	9.99419	9.21656	10.78343	10.00580	10.78924	39
22	9.21152	9.99417	9.21735	10.78264	10.00582	10.78847	48
23	9.21229	9.99415	9.21814	10.78185	10.00585	10.78770	47
24	9.21305	9.99412	9.21892	10.78107	10.00587	10.78694	46
25	9.21381	9.99410	9.21971	10.78029	10.00589	10.78618	35
26	9.21457	9.99408	9.22049	10.77950	10.00591	10.78542	34
27	9.21533	9.99406	9.22127	10.77872	10.00593	10.78466	33
28	9.21609	9.99404	9.22205	10.77794	10.00595	10.78390	32
29	9.21685	9.99402	9.22283	10.77717	10.00597	10.78314	31
30	9.21760	9.99400	9.22360	10.77639	10.00599	10.78239	30
		Sine		Tang.		Secant	
80. *Degrees.*							

9 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.21760	9.99400	9.22360	10.77639	10.00599	10.78235	30
31	9.21836	9.99398	9.22438	10.77561	10.00601	10.7816[illegible]	29
32	9.21911	9.99396	9.22515	10.77484	10.00604	10.78088	28
33	9.21986	9.99393	9.22592	10.77407	10.00606	10.78013	27
34	9.22261	9.99391	9.22670	10.77330	10.00608	10.77938	26
35	9.22136	9.99389	9.22747	10.77252	10.00610	10.77863	25
36	9.22211	9.99387	9.22823	10.77176	10.00612	10.77788	24
37	9.22285	9.99385	9.22900	10.77099	10.00614	10.77713	23
38	9.22360	9.99383	9.22977	10.77022	10.00616	10.77639	22
39	9.22434	9.99381	9.23053	10.76946	10.00618	10.77565	21
40	9.22509	9.99378	9.23130	10.76869	10.00621	10.7749	20
41	9.22583	9.99376	9.23206	10.76793	10.00623	10.77416	19
42	9.22657	9.99374	9.23282	10.75717	10.00525	10.77342	18
43	9.22731	9.99372	9.23358	10.76641	10.00627	10.77268	17
44	9.22804	9.99370	9.23434	10.76565	10.00629	10.77195	16
45	9.22878	9.99368	9.23510	10.76489	10.00631	10.77121	15
46	9.22951	9.99366	9.23585	10.76414	10.00634	10.77048	14
47	9.23025	9.99363	9.23661	10.76338	10.00636	10.76974	13
48	9.23098	9.99361	9.23736	10.76263	10.00638	10.76901	12
49	9.23171	9.99369	9.23812	10.76188	10.00640	10.76828	11
50	9.23244	9.99357	9.23887	10.76112	10.00642	10.76755	10
51	9.23317	9.99355	9.23962	10.76037	10.00545	10.76682	9
52	9.23389	9.99352	9.24037	10.75962	10.00647	10.76610	8
53	9.23462	9.99350	9.24111	10.75888	10.00649	10.76537	7
54	9.23533	9.99348	9.24186	10.75813	10.00651	10.76465	6
55	9.23607	9.99346	9.24261	10.75739	10.00653	10.76392	5
56	9.23679	9.99344	9.24335	10.75664	10.00656	10.76320	4
57	9.23751	9.99341	9.24409	10.75590	10.00558	10.76248	3
58	9.23823	9.99339	9.24483	10.75516	10.00560	10.76176	2
59	9.23895	9.99337	9.24557	10.75442	10.00662	10.76104	1
60	9.23967	9.99335	9.24631	10.75368	10.00664	10.76033	0
		Sine.		Tang.		Secant	M.

80 *Degrees.*

10 Degrees.

M	Sine		Tang.	Secant.			
0	9.23967	9.99335	9.24631	10.75368	10.00664	10.76033	60
1	9.24038	9.99332	9.24705	10.75294	10.00667	10.75961	59
2	9.24110	9.99330	9.24779	10.75220	10.00669	10.75889	58
3	9.24181	9.99328	9.24853	10.75147	10.00671	10.75818	57
4	9.24252	9.99326	9.24926	10.75073	10.00673	10.75747	56
5	9.24323	9.99324	9.24999	10.75000	10.00676	10.75676	55
6	9.24394	9.99321	9.25073	10.74927	10.00678	10.75605	54
7	9.24465	9.99319	9.25146	10.74853	10.00680	10.75534	53
8	9.24536	9.99317	9.25219	10.74780	10.00682	10.75463	52
9	9.24606	9.99314	9.25292	10.74708	10.00685	10.75393	51
10	9.24677	9.99312	9.25364	10.74635	10.00687	10.75322	50
11	9.24747	9.99310	9.25437	10.74562	10.00689	10.75252	49
12	9.24818	9.99308	9.25510	10.74490	10.00691	10.75181	48
13	9.24888	9.99305	9.25582	10.74417	10.00694	10.75111	47
14	9.24958	9.99303	9.25654	10.74345	10.00696	10.75041	46
15	9.25028	9.99301	9.25726	10.74273	10.00698	10.74971	45
16	9.25098	9.99299	9.25799	10.74201	10.00701	10.74902	44
17	9.25167	9.99296	9.25871	10.74129	10.00703	10.74832	43
18	9.25237	9.99294	9.25942	10.74057	10.00705	10.74762	42
19	9.25306	9.99292	9.26014	10.73985	10.00707	10.74693	41
20	9.25376	9.99289	9.26086	10.73913	10.00710	10.74623	40
21	9.25445	9.99287	9.26157	10.73842	10.00712	10.74554	39
22	9.25514	9.99285	9.26229	10.73770	10.00714	10.74485	38
23	9.25583	9.99282	9.26300	10.73699	10.00717	10.74416	37
24	9.25652	9.99280	9.26371	10.73628	10.00719	10.74347	36
25	9.25721	9.99278	9.26442	10.73557	10.00721	10.74278	35
26	9.25789	9.99275	9.26513	10.73486	10.00724	10.74210	34
27	9.25858	9.99273	9.26584	10.73415	10.00726	10.74141	33
28	9.25926	9.99271	9.26655	10.73344	10.00728	10.74073	32
29	9.25995	9.99268	9.26726	10.73273	10.00731	10.74004	31
30	9.26063	9.99266	9.26796	10.73203	10.00733	10.73936	30
		Sine.		Tangent.		Secant.	M

79 Degrees.

10 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.26063	9.99206	9.26796	10.73203	10.00733	10.73937	30
31	9.26131	9.99264	9.26867	10.73132	10.00735	10.73869	29
32	9.26199	9.99261	9.26937	10.73062	10.00738	10.73800	28
33	9.26267	9.99259	9.27007	10.72992	10.00740	10.73733	27
34	9.26335	9.99257	9.27077	10.72922	10.00742	10.73664	16
35	9.26402	9.99254	9.27147	10.72852	10.00745	10.73597	25
36	9.26470	9.99252	9.27217	10.72782	10.00747	10.73529	24
37	9.26537	9.99250	9.27287	10.72712	10.00749	10.73462	23
38	9.26505	9.99247	9.27357	10.72642	10.00752	10.73394	22
39	9.26672	9.99245	9.27426	10.72573	10.00754	10.73327	21
40	9.26739	9.99243	9.27495	10.72503	10.00757	10.73260	20
41	9.26806	9.99240	9.27565	10.72434	10.00759	10.73193	19
42	9.26873	9.99238	9.27635	10.72364	10.00761	10.73123	18
43	9.26940	9.99235	9.27704	10.72295	10.00764	10.73988	17
44	9.27006	9.99233	9.27773	10.72226	10.00766	10.72908	16
45	9.27073	.99231	9.27842	10.72157	10.00768	10.72926	15
46	9.27140	.99228	9.27911	10.72088	10.00771	10.72860	14
47	9.27206	9.99226	9.27980	10.72019	10.00773	10.72793	13
48	9.27272	.99223	9.28048	10.71951	10.00776	10.72727	12
49	9.27338	9.99221	9.28117	10.71882	10.00778	10.72661	11
50	9.27404	9.99219	9.28185	10.71814	10.00781	10.72595	10
51	9.27470	9.99216	9.28254	10.71745	10.00783	10.72529	9
52	9.27536	9.99214	9.28322	10.71677	10.00785	10.72463	8
53	9.27602	9.9211	9.28390	10.71609	10.00788	10.72397	7
54	9.27668	9.99209	9.28458	10.71541	10.00790	10.72331	6
55	9.27733	9.99206	9.28526	10.71473	10.00793	10.72266	5
56	9.27799	9.99204	9.28594	10.71405	10.00795	10.72200	4
57	9.27864	9.99202	9.28662	107.1337	10.00798	10.72135	3
58	9.27929	9.99199	9.28730	10.71269	10.00800	10.72070	2
59	9.27994	9.99197	9.28797	10.71202	10.00802	10.72004	1
60	9.28059	9.99194	9.28865	10.71134	10.00805	10.71940	0
		Sine		Tang.		Secant	M.

79 *Degrees.*

11 *Degrees.*

M.	Sine		Tang.		Secant.		
0	9.28059	9.99164	9.28865	10.71134	10.00805	10.71840	60
1	9.28124	9 99152	9.28923	10.71067	10.00807	10.71875	59
2	9.28189	9 99189	9.28999	10.71000	10.00810	10.71810	58
3	9.28254	9.99187	9.29057	10.70932	10.00812	10.71745	57
4	9.28319	9.99184	9.29134	10.70865	10.00815	10.71680	56
5	9.28383	9,99182	9.29201	10.70798	10.00817	10.71616	55
6	9.28448	9.99179	9.29268	10.70731	10.00820	10.71552	54
7	9.28512	9.99177	9.29335	10.70665	10.00822	10.71487	53
8	9.28576	9.99174	9.29401	10.70598	10.00825	10.71423	52
9	9.28640	9.99172	9.29458	10.70531	10.00827	10.71359	51
10	9.28704	9.99169	9.29534	10.70465	10.00830	10.71295	50
11	9.28768	9.99167	9.29601	10.70398	10 00832	10.71231	49
12	9.28832	9.99164	9.29667	10.70332	10.00935	10.7116[illegible]	48
13	9.28896	9.99162	9.29733	10.70266	10.00837	10.71103	47
14	9.28960	9.99159	9.29800	10.70199	10 00840	10.71040	46
15	9.29024	9.99157	9.29866	10.70133	10.00842	10.70976	45
16	9.29087	9.99154	9.29932	10.70067	10.00845	10 70913	44
17	9.29150	9.99152	9.29998	10.70002	10.00847	10.70849	43
18	9.29213	9.99149	9.30053	10.69636	10.00850	10.70786	42
19	9 29276	9.99147	9.3[illegible]129	10.59870	10.00853	10.70723	41
20	9.29339	9.99144	9.30195	10.69804	10.0085[illegible]	10.70660	40
21	9.29402	9.99142	9.30260	10.69739	10.00857	10.7059[illegible]	39
22	9.29465	9.99139	9.30326	10.69673	10.00860	10.70534	38
23	9.29528	9.[illegible]9137	9.30391	10.69608	10.00862	10.7[illegible]471	37
24	9.29591	9.99134	9.30456	10.69543	10 00865	10.70408	36
25	9.2[illegible]653	9.99132	9.30521	10.69478	10.00867	10.70346	35
26	9.29716	9.99129	9.30586	10.69413	10.00870	10.70283	34
27	9.29778	9.99127	9.30651	10.69348	10.00873	10.70221	33
28	9.29841	9.99124	9.30716	10.69283	10.00875	10.70158	32
29	9.29903	9.99121	9.30781	10.69218	10.00878	10.7009[illegible]	31
30	9.29965	9.99119	9.30846	10.69153	10.00880	10.70034	30
		Sine		Tangent.		Secant.	M.

78 *Degrees.*

11. Degrees.

M.	Sine		Tang.		Secant		
30	9.29965	9.99119	9.30846	10.69153	10.00880	10.70034	30
31	9.30027	9.99116	9.30910	10.69089	10.00883	10.69972	29
32	9.30089	9.99114	9.30975	10.69024	10.00885	10.69910	28
33	9.30151	9.99111	9.31039	10.689[illegible]	10.00888	10.69848	27
34	9.30213	9.99109	9.31104	10.68895	10.00891	10.69786	26
35	9.30274	9.99106	9.31168	10.68831	10.00893	10.69725	25
36	9.3033	9.99103	9.31232	10.68767	10.00896	10.69663	24
37	9.30397	9.99101	9.31296	10.68703	10.00898	10.69602	23
38	9.30459	9.99098	9.31360	10.68639	10.00901	10.69540	22
39	9.30520	9.99096	9.31424	10.68575	10.00904	10.69479	21
40	9.30581	9.99093	9.31488	10.68511	10.00906	10.69418	20
41	9.30643	9.99090	9.31552	10.68447	10.00909	10.69357	19
42	9.30704	9.99088	9.31615	10.68384	10.00911	10.69295	18
43	9.3076	9.99085	9.31679	10.68320	10.00914	10.69235	17
44	9.30825	9.99082	9.31743	10.68257	10.00917	10.69174	16
45	9.30886	9.9908	9.31800	10.68193	10.00919	10.69113	15
46	9.30947	9.99077	9.31869	10.68130	10.00922	10.69052	14
47	9.31008	9.99075	9.31932	10.68067	10.00925	10.68992	13
48	9.31068	9.99072	9.31996	10.68003	10.00927	10.68931	12
49	9.31828	9.99069	9.32059	10.67940	10.00930	10.68871	11
50	9.3118	9.99067	9.32122	10.67877	10.00932	10.68810	10
51	9.3124[illegible]	9.99064	9.32185	10.67814	10.00935	10.68750	9
52	9.31309	9.99061	9.32247	10.67752	10.00938	10.68690	8
53	9.31369	9.99059	9.32310	10.67[illegible]	10.00940	10.68630	7
54	9.3142[illegible]	9.99056	9.32373	10.67626	10.00943	10.68570	6
55	9.31489	9.99053	9.32435	10.67564	10.00945	10.68510	5
56	9.31549	9.99051	9.32498	10.67501	10.00948	10.68450	4
57	9.3 605	9.99048	9.325[illegible]	10.67439	10.0 951	10.68390	3
58	9.31668	9.99045	9.32623	10.67376	10.00954	10.68331	2
59	9.31728	9.99043	9.32685	10.67314	10.00[illegible]	10.68271	1
60	9.31787	9.99040	9.3284[illegible]	10.67252	10.0095[illegible]	10.68212	0
		Sine		Tang.		Secant	M.

78. Degrees.

12 Degrees.							
M.	Sine.		Tang.		Secant		
0	9.31787	9.99046	9.32747	10.67252	10.00959	10.68212	60
1	9.31847	9.99037	9.3280[illegible]	10.67190	10.00962	10.68152	59
2	9.31906	9.99035	9.32871	10.67128	10.00964	10.68093	58
3	9.31965	9.99032	9.32933	10.67066	10.00967	10.68034	57
4	9.32024	9.99029	9.32995	10.67004	10.00970	10.67975	56
5	9.32084	9.99027	9.33057	10.66994	10.00973	10.67916	55
6	9.32143	9.99024	9.33118	10.66881	10.00975	10.67857	54
7	9.32201	9.99021	9.33180	10.66819	10.00978	10.67798	53
8	9.32260	9.99018	9.33241	10.66758	10.00981	10.67739	52
9	9.32319	9.99016	9.33303	10.66696	10.00983	10.67680	51
10	9.32378	9.99013	9.33364	10.66635	10.00986	10.67622	50
11	9.32436	9.99010	9.33425	10.66574	10.00989	10.67563	49
12	9.32495	9.99007	9.33487	10.66512	10.00992	10.67504	48
13	9.32553	9.99005	9.33548	10.66451	10.00994	10.67446	47
14	9.32611	9.99002	9.33609	10.66390	10.00997	10.67388	46
15	9.32670	9.98999	9.33670	10.66329	10.01000	10.67330	45
16	9.32728	9.98997	9.33731	10.66268	10.01003	10.67271	44
17	9.32786	9.98994	9.33791	10.66208	10.01005	10.67213	43
18	9.32844	9.98991	9.33852	10.66147	10.01008	10.67155	42
19	9.32902	9.98988	9.33513	10.66086	10.01011	10.67097	41
20	9.32959	9.98985	9.33973	10.66026	10.01014	10.67040	40
21	9.33017	9.98983	9.34034	10.65965	10.01016	10.66982	39
22	9.33075	9.98980	9.34094	10.65905	10.01019	10.66924	38
23	9.33132	9.98977	9.34155	10.65844	10.01022	10.66867	57
24	9.33190	9.98974	9.34215	10.65784	10.01025	10.66809	36
25	9.33247	9.98972	9.34275	10.65724	10.01027	10.66752	35
26	9.33305	9.9895	9.34335	10.65664	10.01030	10.66694	34
27	9.33362	9.98966	9.34395	10.65604	10.01033	10.66637	33
28	9.33419	9.98963	9.34455	10.65544	10.01036	10.66589	32
29	9.33476	9.98960	9.34515	10.65484	10.01039	10.66523	31
30	9.33533	9.98958	9.34575	10.65424	10.01041	10.66460	30
		Sine		I ang.		Secant	M.
77 Degrees.							

12. *Degrees.*

M.	Sine		Tang.		Secant		
30	9.33533	9.98958	9.34575	10.65424	10.0104[illegible]	10.66466	30
31	9.33590	9.98955	9.34635	10.65364	10.0104[illegible]	10.66409	29
32	9.33647	9.98952	9.34694	10.65305	10.01047	10.66352	28
33	9.33704	9.98949	9.34754	10.65245	10.01050	10.66295	27
34	9.33761	9.98946	9.34814	10.65185	10.01053	10.6623[illegible]	26
35	9.33817	9.98944	9.34873	10.65126	10.01055	10.66182	25
36	9.3387[illegible]	9.98941	9.34932	10.65067	10.01058	10.66125	24
37	9.339[illegible]	9.98938	9.34992	10.65007	10.01061	10.66069	23
38	9.33987	9.98935	9.35051	10.64948	10.01064	10.66012	22
39	9.34043	9.98932	9.35110	10.64889	10.01067	10.65956	21
40	9.34099	9.98929	9.35169	10.64830	10.01070	10.65900	20
41	9.34155	9.98927	9.35228	10.64771	10.01072	10.65844	19
42	9.34211	9.98924	9.35287	10.64712	10.01075	10.65788	18
43	9.34267	9.98921	9.35346	10.64653	10.01078	10.65732	17
44	9.34323	9.98918	9.35405	10.64594	10.01081	10.65676	16
45	9.34379	9.98915	9.35464	10.64536	10.01084	10.65620	15
46	9.34435	9.98912	9.35522	10.64477	10.01087	10.6556[illegible]	14
47	9.34491	9.98910	9.35581	10.64418	10.01090	10.65508	13
48	9.34546	9.98907	9.35639	10.64360	10.01092	10.65453	12
49	9.34602	9.98904	9.35698	10.64301	10.01095	10.65397	11
50	9.34657	9.98901	9.35756	10.64243	10.01098	10.65342	40
51	9.34713	9.98898	9.35814	10.64185	10.01101	10.65286	39
52	9.34768	9.98895	9.35873	10.64126	10.01104	10.65231	38
53	9.34824	9.98892	9.35931	10.64068	10.01107	10.65176	37
54	9.34879	9.9888[illegible]	9.35989	10.640[illegible]	10.01110	10.65120	36
55	9.34936	9.98886	9.36047	10.63952	10.01113	10.65065	35
56	9.34989	9.98884	9.36105	10.63894	10.01116	10.65010	34
57	9.35044	9.98881	9.36163	10.63836	10.01118	10.64955	33
58	9.35099	9.98878	9.36221	10.63779	10.01121	10.64900	32
59	9.3515	9.98875	9.36278	10.63721	10.01124	10.64845	31
60	9.35208	9.98872	9.36236	10.63663	10.01127	10.64791	30
		Sine		Tang.		Secant	M.

77. *Degrees.*

13 *Degrees.*

M.	Sine.		Tang.		Secant		
0	9.35208	9.98872	9.35336	10.63663	10.01127	10.64791	60
1	9.35263	9.98868	9.36394	10.63606	10.01130	10.64736	59
2	9.35318	9.98866	9.30451	10.63548	10.01133	10.64681	58
3	9.35372	9.98863	9.36509	10.63491	10.01136	10.64627	57
4	9.35427	9.98860	9.36566	10.63433	10.01139	10.64572	56
5	9.35481	9.98857	9.36623	10.63376	10.01142	10.64518	55
6	9.35535	9.98854	9.36681	10.63319	10.01145	10.64464	54
7	9.35590	9.98851	9.36738	10.63261	10.01148	10.64409	53
8	9.35644	9.98848	9.36795	10.63204	10.01151	10.64355	52
9	9.35698	9.98846	9.36852	10.63147	10.01154	10.64301	51
10	9.35752	9.98843	9.36909	10.63090	10.01157	10.64247	50
11	9.35806	9.98840	9.36966	10.63033	10.01159	10.64193	49
12	9.35860	9.98837	9.37023	10.62976	10.01162	10.64139	48
13	9.35914	9.98834	9.37079	10.62920	10.01165	10.64085	47
14	9.35967	9.98831	9.37136	10.62863	10.01168	10.64032	46
15	9.36021	9.98828	9.37193	10.62800	10.01171	10.63978	45
16	9.36075	9.98825	9.3724[illegible]	10.62750	10.01174	10.63924	44
17	9.36128	9.98822	9.37306	10.62693	10.01177	10.63871	43
18	9.36182	9.98819	9.37362	10.62637	10.01180	10.63817	42
19	9.36235	9.98816	9.37419	10.62580	10.01183	10.63764	41
20	9.36288	9.98813	9.37475	10.62524	10.01186	10.63711	40
21	9.36342	9.98810	9.37531	10.62468	10.01189	10.63657	39
22	9.36395	9.98807	9.37588	10.62411	10.01192	10.63604	38
23	9.36448	9.[illegible]8804	9.37644	10.62355	10.01195	10.63551	37
24	9.36501	9.98801	9.37700	10.62299	10.01198	10.63498	36
25	9.36554	9.98798	9.37756	10.62243	10.01201	10.63445	35
26	9.36607	9.98795	9.37812	10.62187	10.01204	10.63392	34
27	9.36660	9.98792	9.37868	10.62131	10.01207	10.63339	33
28	9.36713	9.98789	9.37923	10.62076	10.01210	10.63286	32
29	9.36765	9.98786	9.37979	10.62020	10.01213	10.63234	31
30	9.36818	9.98783	9.38035	10.61964	10.01216	10.63181	30
		Sine		Tang.		Secant	M.

76 *Degrees.*

13 *Degrees.*

M	Sine		Tang.		Secant.		
30	9.36818	9.98783	9.38035	10.61964	10.01216	10.63181	30
31	9.36871	9.98780	9.38091	10.61909	10.01219	10.63128	29
32	9.36923	9.98777	9.38146	10.61853	10.01222	10.63076	28
33	9.36976	9.98774	9.38202	10.61797	10.01226	10.63023	27
34	9.37028	9.98771	9.38257	10.61742	10.01229	10.62971	26
35	9.3708[illegible]	9.98767	9.38312	10.61687	10.01232	10.62919	25
36	9.37133	9.98764	9.38368	10.61631	10.01235	10.62867	24
37	9.37185	9.98761	9.38423	10.61576	10.01238	10.62814	23
38	9.37237	9.98758	9.38478	10.61521	10.01241	10.62762	22
39	9.37289	9.98755	9.38533	10.61466	10.01244	10.62710	21
40	9.37341	9.98752	9.38588	10.61411	10.01247	10.62658	20
41	9.37393	9.98749	9.3864[illegible]	10.61356	10.01250	10.62606	19
42	9.37445	9.98740	9.38698	10.61301	10.01253	10.62554	18
43	9.37497	9.98743	9.38753	10.61246	10.01256	10.62503	17
44	9.37548	9.9874	9.38808	10.61191	10.01259	10.62451	16
45	9.3760[illegible]	9.98737	9.38863	10.01136	10.01262	10.62399	15
46	9.37651	9.98734	9.38917	10.61082	10.01265	10.62348	14
47	9.37703	9.98731	9.38972	10.61027	10.01269	10.62295	13
48	9.37754	9.98727	9.39027	10.60973	10.01272	10.62245	12
49	9.37806	9.98724	9.39081	10.60916	10.01275	10.62193	11
50	9.37857	9.98721	9.39135	10.60864	10.01278	10.62142	10
51	9.37908	9.98718	9.39190	10.60809	10.01281	10.62091	9
52	9.37960	9.98715	9.39244	10.60755	10.01284	10.62039	8
53	9.38011	9.98712	9.39298	10.60701	10.01287	10.61983	7
54	9.38062	9.98709	9.39352	10.60644	10.01290	10.61937	6
55	9.38113	9.98706	9.39407	10.60592	10.012[illegible]3	10.6188[illegible]	5
56	9.38164	9.98703	9.39461	10.60538	10.01297	10.6183[illegible]	4
57	9.38215	9.98699	9.39515	10.60484	10.0130[illegible]	10.61784	3
58	9.38266	9.9869[illegible]	9.39569	10.60430	10.01303	10.6173[illegible]	2
59	9.38316	9.98693	9.39623	10.6037[illegible]	10.01306	10.61[illegible]8[illegible]	1
60	9.38367	9.98690	9.39677	10.[illegible]03[illegible]2	10.01[illegible]0[illegible]	10.61632	0
		Sine.		Tangent.		Secant.	M.

76 *Degrees.*

14 *Degrees.*							
M.	*Sine.*		Tang		Secant.	Tang.	
0	9.38367	9.98690	9.39677	10.60322	10.[illegible]1309	10.61632	60
1	9.38418	9.98687	9.39730	10.60269	10.01312	10.61581	59
2	9.38468	9.98684	9.39784	10.60215	10.01315	10.61534	58
3	9.38519	9.98680	9.39838	10 60161	10.01319	10.61480	57
4	9.38569	9.98677	9.39891	10.60108	10.01322	10.61430	56
5	9.38620	9.98674	9.39945	10.60054	10.01325	10.61379	55
6	9.38670	9 98671	9.39999	10.60001	10.01328	10.61329	54
7	9.38720	9.98668	9.40052	10.59947	10.01331	10.61279	53
8	9.38770	9.98665	9.40105	10.59894	10.01334	10.61229	52
9	9.38821	9.98661	9.40159	10.5984[illegible]	10 01338	10.61179	51
10	9.38871	9.98658	9.40212	10 59787	10.01341	10.61128	50
11	9.38921	9.98655	9.40265	10.59734	10.01344	10.61078	49
12	9.38971	9.98652	9.40318	10.59681	10.01347	10.61028	48
13	9.39021	9.98649	9.40371	10.59628	10.01350	10.60979	47
14	9.39070	9.98645	9 40424	10.59575	10.01354	10 60929	46
15	9.39120	9.98642	9.40477	10.59522	10.01357	10.60879	45
16	9.39170	9.98639	9.40530	10.59469	10.01360	10.60829	44
17	9.39219	9.98636	9.40583	10.59416	10.01363	10.60780	43
18	9.39269	9.98633	9.40636	10.59363	10.01366	10.60730	42
19	9.39319	9.98629	9.40689	10.59310	10.01370	10.60680	41
20	9.39368	9.98626	9.40741	10.59258	10.01373	10.60631	40
21	9.39417	9.98623	9.40794	10.59205	10.01376	10.60582	39
22	9.39467	9.98620	9.40847	10.59152	10.01379	10.60532	38
23	9.39516	9.98616	9.40899	10.59100	10.01383	10.60483	37
24	9.39565	9.98613	9.40952	10.59047	10.01386	10.60434	36
25	9.39615	9.98510	9.41004	10.58995	10.01389	10.6[illegible]385	35
26	9.39664	9.98607	9 41056	10.58943	10.01392	10.60335	34
27	9.39713	9.98603	9.41109	10.58890	10.01396	10.60286	33
28	9.39762	9.98600	9.41161	10.58838	10.01399	10.60237	32
29	9.3981[illegible]	9.98597	9.41213	10.58786	10.01402	10.60188	31
30	9.3986[illegible]	9.98594	9.41265	10.58734	10.01405	10.60140	30
		Sine.		Tang.		Secant.	
75 *Degrees.*							

14 Degrees.

M	Sine		Tang.		Secant.		
30	9.39860	9.98594	9.41205	10.58734	10.01405	10.60140	30
31	9.39908	9.98590	9.41317	10.58682	10.01409	10.60091	29
32	9.39957	9.98587	9.41359	10.58630	10.01412	10.60042	28
33	9.40006	9.98584	9.41421	10.58578	10.01415	10.59993	27
34	9.40054	9.98581	9.41473	10.58526	10.01418	10.59945	26
35	9.40103	9.98577	9.41525	10.58474	10.01422	10.59896	25
36	9.40152	9.98574	9.41577	10.58422	10.01425	10.59848	24
37	9.40200	9.98571	9.41629	10.58370	10.01428	10.59799	23
38	9.40248	9.98567	9.41681	10.58319	10.01432	10.59751	22
39	9.40297	9.9856[illegible]	9.41732	10.58267	10.01435	10.59702	21
40	9.40345	9.98561	9.41784	10.58215	10.01438	10.59654	20
41	9.40393	9.98558	9.41835	10.58164	10.01442	10.59606	19
42	9.40442	9.98554	9.41887	10.58112	10.01445	10.59558	18
43	9.40490	9.98551	9.41938	10.58061	10.01448	10.59509	17
44	9.40538	9.98548	9.41990	10.58009	10.01452	10.59461	16
45	9.4058[illegible]	9.98544	9.42041	10.57958	10.01455	10.59413	15
46	9.40634	9.98541	9.42092	10.57907	10.01458	10.59365	14
47	9.40682	9.98538	9.42144	10.57856	10.01461	10.59318	13
48	9.40729	9.98534	9.42195	10.57804	10.01465	10.59270	12
49	9.40777	9.98531	9.4224[illegible]	10.57753	10.01468	10.59222	11
50	9.40825	9.98528	9.42297	10.57702	10.01472	10.59174	10
51	9.40873	9.98524	9.42348	10.57651	10.01475	10.59126	9
52	9.40920	9.98521	9.42399	10.57600	10.01478	10.59079	8
53	9.40968	9.98518	9.42450	10.57549	10.01482	10.59031	7
54	9.41015	9.98514	9.42501	10.57498	10.0148[illegible]	10.58984	6
55	9.41063	9.98511	9.42551	10.57448	10.01488	10.58936	5
56	9.41110	9.98507	9.42602	10.57397	10.01492	10.58889	4
57	9.41157	9.98504	9.42653	10.57346	10.01495	10.58842	3
58	9.41205	9.98501	9.42704	10.57295	10.01498	10.58794	2
59	9.41252	9.98497	9.42754	10.57245	10.01502	10.58747	1
60	9.41299	9.98494	9.42805	10.57194	10.01505	10.58700	0
		Sine.		Tangent.		Secant.	M

75 Degrees.

15 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.41299	9.98494	9.42805	10.57194	10.01505	10.58 70	60
1	9.41346	9.98491	9.42855	10.57144	10.01509	10.58653	59
2	9.41393	9.98487	9.42906	10.57093	10.01512	10.58606	58
3	9.41440	9.98484	9.42956	10.57043	10.01515	10.58559	57
4	9.41487	9.98480	9.43007	10.56993	10.01519	10.58512	56
5	9.41534	9.98477	9.43057	10.56942	10.01522	10.58465	55
6	9.41581	9.98474	9.43107	10.56892	10.01526	10.58418	54
7	9.41628	9.98470	9.43157	10.56842	10.01529	10.58371	53
8	9.41675	9.98467	9.43207	10.56792	10.01532	10.58324	52
9	9.41721	9.98463	9.43258	10.56742	10.01536	10.58278	51
10	9.41768	9.98460	9.43308	10.56692	10.01539	10.58231	50
11	9.41814	9.98456	9.43358	10.56641	10.01543	10.58185	49
12	9.41861	9.98453	9.43408	10.56592	10.01546	10.58138	48
13	9.41907	9.98450	9.43457	10.56542	10.01550	10.58092	47
14	9.41954	9.98446	9.43507	10.56492	10.01553	10.58045	46
15	9.42000	9.98443	9.43557	10.56442	10.01556	10.57999	45
16	9.42047	9.98439	9.43607	10.56392	10.01560	10.57953	44
17	9.42093	9.98436	9.43657	10.56343	10.01563	10.57906	43
18	9.42139	9.98432	9.43706	10.56293	10.01567	10.57860	42
19	9.42185	9.98429	9.43756	10.56243	10.01570	10.57814	41
20	9.42231	9.98425	9.43805	10.56194	10.01574	10.57768	40
21	9.42277	9.98422	9.43855	10.56144	10.01577	10.57722	39
22	9.42323	9.98418	9.439[illegible]4	10.56095	10.01581	10.57676	38
23	9.42369	9.98415	9.43954	10.56045	10.01584	10.57630	37
24	9.42415	9.98412	9.44003	10.55996	10.01588	10.57584	36
25	9.42461	9.98408	9.44052	10.5594[illegible]	10.01591	10.57538	35
26	9.42507	9.98405	9.44102	10.55897	10.01595	10.57492	34
27	9.42553	9.98401	9.44151	10.55848	10.01598	10.57447	33
28	9.42598	9.98398	9.44200	10.55799	10.01601	10.57401	32
29	9.42644	9.98394	9.44249	10.55750	10.01605	10.57355	31
20	9.42689	9.98391	9.44298	10.55701	10.01608	10.57310	30
		Sine		Tang.		Secant.	M.

74 *Degrees.*

15 *Degrees.*

M.	Sine		Tang.		Secant.		
30	9.42639	9.98391	9.44298	10.55701	10.01608	10.57310	30
31	9.42735	9.98387	9.44347	10.55652	10.01612	10.57264	29
32	9.42780	9.98384	9.44396	10.55603	10.01616	10.57219	28
33	9.42826	9.98380	9.44445	10.55554	10.01619	10.57173	27
34	9.42871	9.98377	9.44494	10.55505	10.01623	10.57128	26
35	9.42917	9,98373	9.44548	10.55456	10.01520	10.57083	25
36	9.42962	9.98370	9.44592	10.55407	10.01630	10.57037	24
37	9.43007	9.98366	9.44641	10.55356	10.01633	10.56992	23
38	9.43052	9.98362	9.44639	10.55310	10.01637	10.56947	22
39	9.43097	9.98359	9.44738	10.55261	10.01640	10.56902	21
40	9.43142	9.98355	9.44787	10.55213	10.01644	10.56857	20
41	9.43187	9.98352	9.44835	10.55165	10.01647	10.56812	19
42	9.43232	9.98348	9.44884	10.55115	10.01651	10.56767	18
43	9.43277	9.98345	9.44932	10.55067	10.01654	10.56722	17
44	9.43322	9.98341	9.44981	10.55019	10.01658	10.56677	16
45	9.43367	9.98338	9.45029	10.54970	10.01661	10.56632	15
46	9.43412	9.98334	9.45077	10.54922	10.01665	10.56587	14
47	9.43456	9.98330	9.45126	10.54874	10.01669	0.56543	13
48	9.43501	9.98327	9.45174	10.54825	10.01672	10.56498	12
49	9.43546	9.98323	9.45222	10.54777	10.01676	10.56453	11
50	9.43590	9.98320	9.45270	10.54729	10.01579	10.56409	10
51	9.43535	9.98316	9.45318	10.54681	10.01683	10.56364	9
52	9.43679	9.98313	9.45367	10.54633	10.01687	10.56320	8
53	9.43724	9.98309	9.45414	10.54585	10.01690	10.56275	7
54	9.43768	9.98305	9.45462	10.54537	10.01594	10.56231	6
55	9.43812	9.98302	9.45510	10.54489	10.01697	10.56187	5
56	9.43857	9.98293	9.45558	10.54441	10.01701	10.56142	4
57	9.43901	9.98295	9.45606	10.54393	10.01705	10.56098	3
58	9.43945	9.98291	9.45654	10.54345	10.01708	10.56054	2
59	9.43689	9.98287	9.45701	10.54298	10.01712	10.56010	1
60	9.44033	9.98284	9.45749	10.54250	10.01715	10.55966	0
		Sine		Tangent.		Secant.	M.

74 *Degrees.*

16 Degrees.							
M.	Sine.		Tang		Secant.		
0	9.44035	9.98284	9.45748	10.54250	10.[illegible]1715	10.55966	60
1	9.440[illegible]7	9.98280	9.45797	10.54202	10.01719	10.55922	59
2	9.44121	9.98276	9.45844	10.54155	10.01723	10.55878	58
3	9.44165	9.98273	9.45892	10.54107	10.01720	10.55834	57
4	9.44209	9.98269	9.45940	10.54[illegible]60	10.01730	10.5579[illegible]	56
5	9.44253	9.98266	9.45987	10.54012	10.01734	10.55746	55
6	9.44297	9.98262	9.46034	10.53965	10.01737	10.55702	54
7	9.4434[illegible]	9.98258	9.46082	10.53917	10.01741	10.55659	53
8	9.44384	9.98255	9.46129	10.53870	10.01744	10.5561[illegible]	52
9	9.44428	9.98251	9.46177	10.52823	10.01748	10.55571	51
10	9.44472	9.98247	9.46224	10.53775	10.01752	10.55528	50
11	9.44515	9.98244	9.46271	10.53728	10.01755	10.55484	49
12	9.44559	9.98240	9.46318	10.[illegible]3681	10.01759	10.5[illegible]441	48
13	9.44602	9.98236	9.46365	10.53634	10.01763	10.55398	47
14	9.44645	9.98233	9.46412	10.53587	10.01766	10.55354	46
15	9.44689	9.98229	9.46459	10.53540	10.01770	10.55310	45
16	9.44732	9.98225	9.46506	10.53493	10.01774	10.55267	44
17	9.44775	9.98222	9.46553	10.53446	10.01778	10.55224	43
18	9.44819	9.98218	9.46600	10.53399	10.01781	10.5518[illegible]	42
19	9.44862	9.98214	9.46647	10.53352	10.01785	10.55137	41
20	9.44905	9.98210	9.46694	10.53305	10.01789	10.5509[illegible]	40
21	9.44928	9.98207	9.46741	10.53258	10.01792	10.55050	39
22	9.44991	9.98203	9.46788	10.53212	10.01796	10.55008	38
23	9.45034	9.98199	9.46834	10.5316[illegible]	10.0180[illegible]	10.5496[illegible]	37
24	9.45077	9.98196	9.46881	10.53118	10.01803	10.54922	36
25	9.45120	9.98192	9.46928	10.53072	10.01807	10.54879	35
26	9.45163	9.98188	9.46974	10.53025	10.01811	10.54836	34
27	9.45206	9.98184	9.47021	10.52978	10.01815	10.54794	33
28	9.45248	9.98181	9.47067	10.52922	10.01818	10.54751	32
29	9.45291	9.98177	9.47114	10.52885	10.01822	10.54708	31
30	9.45334	9.98173	9.47160	10.52839	10.01826	10.5466[illegible]	30
		Sine.		Tang.		Secant.	
73 Degrees.							

16 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.45334	9.98173	9.47160	10.52839	10.01826	10.54665	30
31	9.45376	9.98169	9.47206	10.52793	10.01830	10.54623	29
32	9.45419	9.98166	9.47253	10.52746	10.01833	10.54580	28
33	9.45461	9.98162	9.47299	10.52700	10.01837	10.54538	27
34	9.45504	9.98158	9.47345	10.52654	10.01841	10.54495	26
35	9.45546	9.98154	9.47391	10.52608	10.01845	10.54453	25
36	9.45589	9.98151	9.47438	10.52561	10.01848	10.54410	24
37	9.45631	9.98147	9.47484	10.52515	10.01852	10.54368	23
38	9.45673	9.98143	9.47530	10.52469	10.01856	10.54326	22
39	9.45716	9.98139	9.47576	10.52423	10.01860	10.54283	21
40	9.45758	9.98136	9.47622	10.52377	10.01863	10.54241	20
41	9.45800	9.98132	9.47668	10.52331	10.01867	10.54199	19
42	9.45842	9.98128	9.47714	10.52285	10.01871	10.54157	18
43	9.45884	9.98124	9.47760	10.52239	10.01875	10.54115	17
44	9.45926	9.98120	9.47805	10.52194	10.01879	10.54073	16
45	9.45968	9.98117	9.47851	10.52148	10.01882	10.54031	15
46	9.46010	9.98113	9.47897	10.52102	10.01886	10.53989	14
47	9.46052	9.98109	9.47943	10.52056	10.01890	10.53947	13
48	9.46094	9.98105	9.47988	10.52011	10.01894	10.53905	12
49	9.46136	9.98101	9.48034	10.51965	10.01898	10.53863	11
50	9.46178	9.98098	9.48080	10.51919	10.01901	10.53821	10
51	9.46219	9.98094	9.48125	10.51874	10.01905	10.53780	9
52	9.46261	9.98090	9.48171	10.51828	10.01909	10.53738	8
53	9.46303	9.98086	9.48216	10.51783	10.01913	10.53696	7
54	9.46344	9.98082	9.48262	10.51737	10.01917	10.53655	6
55	9.46386	9.98078	9.48307	10.51692	10.01921	10.53613	5
56	9.46427	9.98075	9.48352	10.51647	10.01924	10.53572	4
57	9.46469	9.98071	9.48398	10.51601	10.01928	10.53530	3
58	9.46510	9.98067	9.48443	10.51556	10.01932	10.53489	2
59	9.46555	9.98063	9.48488	10.51511	10.01936	10.53447	1
60	9.46593	9.98059	9.48533	10.51466	10.01940	10.53406	0
		Sine		Tang.		Secant.	M

73 *Degrees.*

17 *Degrees.*

M.	Sine.		Tang.		Secant.		
0	9.46593	9.98059	9.48533	10.5146	10. 1940	10.534[illegible]	60
1	9.46634	9.98055	9.48579	10.51420	10.01944	10.5336[illegible]	59
2	9.46576	9.98051	9.48624	10.51375	10.01948	10.5332[illegible]	58
3	9.46717	9.98048	9.48669	10.5133	10.01952	10.53282	57
4	9.46758	9.98044	9.48714	10.5128[illegible]	10.01955	10.53241	56
5	9.46799	9.98040	9.48759	10.5124	10.01959	10.53200	55
6	9.46840	9.98036	9.48804	10.51195	10.01962	10.53159	54
7	9.46881	9.98032	9.48849	10.51150	0.01967	10.53118	53
8	9.46922	9.98028	9.48894	10.51105	10.01971	10.53077	52
9	9.46963	9.98024	9.48939	10.51061	10.01975	10.53036	51
10	9.47004	9.98020	9.48983	10.51016	10.01979	10.52995	50
11	9.47045	9.98016	9.49028	10.50971	10.01983	10.52954	49
12	9.47086	9.98013	9.49073	10.50926	10.01987	10.52913	48
13	9.47127	9.98009	9.49118	10.50882	10.0199	10.52872	47
14	9.47167	9.98005	9.40162	10.50837	10.01094	10.5283[illegible]	46
15	9.47208	9.98001	9.49207	10.50792	10.01998	10.5279[illegible]	45
16	9.47249	9.97997	9.49251	10.50748	10.02002	10.52750	44
17	9.47289	9.97993	9.49296	10.50703	10.02006	10.52710	43
18	9.47230	9.97989	9.49341	10.50656	10.02010	10.52665	42
19	9.47371	9.97985	9.49385	10.50614	10.02014	10.52629	41
20	9.47411	9.97981	9.49429	10.50570	10.02018	10.52588	40
21	9.47451	9.97977	9.49474	10.50525	10.02022	10.52548	39
22	9.47492	9.97973	9.49518	10.50481	10.02026	10.52507	38
23	9.47532	9.97969	9.49563	10.50437	10.02030	10.52467	37
24	9.47573	9.97965	9.49607	10.50392	10.02034	10.52427	36
25	9.47613	9.97961	9.49651	10. 0348	10.02038	10.52386	35
26	9.47653	9.97957	9.49695	10.50304	10.02042	10.52346	34
27	9.47693	9.97953	9.49739	10.5026[illegible]	10.02046	10.52306	33
28	9.47734	9.97949	9.49784	10.50215	10.02050	10.52266	32
29	9.47774	9.97945	9.49828	10.50171	10.02054	10.5222[illegible]	31
30	9.47814	9.97941	9.49872	10.50127	10.02058	10.52185	30
		Sine.		Tang.		Secant.	

72 *Degrees.*

17 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.47814	9.97941	9.49872	10.50127	10. 2058	10.52185	30
31	9.47854	9.97938	9.49916	10.50083	10.02 62	10.52145	29
32	9.47894	9.97934	9.49950	10.50039	10.02066	10.52105	28
33	9.47934	9.97930	9.50004	10.4999[illegible]	10.02070	10.52065	27
34	9.47974	9.97926	0.50048	10.49951	10. 2074	10.52025	26
35	9.48012	9.97922	9.50 92	10.499 8	10.02078	10.51986	25
36	9.48053	9.97918	9.50135	10.49864	10.02082	10.51946	24
37	9.48 93	9.97914	9.5017	10.49820	10.02086	10.51906	23
38	9.48133	9.97910	9.50223	10.4 776	10.02090	10.51866	22
39	9.48173	9.97905	9.50267	10.49732	10.02094	10.51826	21
40	9.48212	9.97901	9.50310	10.49689	10.02098	10.51787	20
41	9.48251	9.97897	9.50354	10.49645	10.02102	10.51747	19
42	9.48292	9.97893	9.50398	10.49601	10.02106	10.51707	18
43	9.48331	9.97889	9.50441	10.49558	10.02110	10.51668	17
44	9.48371	9.97885	9.50483	10.49514	10.02114	10.51628	16
45	9.48410	9.97881	9.50528	10.49471	10.02118	10.51589	15
46	9.48450	9.97877	9.50572	10.49427	10.02122	10.51549	14
47	9.48489	9.97873	9.50615	10.49384	10.02126	10.51510	13
48	9.48528	9.97869	9.50659	10.49340	10.02130	00.51471	12
49	9.48568	9.97865	9.50702	10.49297	10.02134	10.51431	11
50	9.48607	9.97861	9.50746	10.49254	10.02138	10.51392	10
51	9.48646	9.97857	9.50789	10.49210	10.02142	10.51353	9
52	9.48685	9.97853	9.50832	10.49167	10.02146	10.51314	8
53	9.48725	9.97849	9.50375	10.49124	10.02150	10.51274	7
54	9.48764	9.97845	9.50919	10.49080	10.02154	10.51235	6
55	9.48803	9.97841	9.50962	10.49037	10.02158	10.51196	5
56	.48842	9.97837	9.51005	10.48994	10.02163	10.51157	4
57	9.48881	9.97832	9.51048	10.48951	10.02167	10.51118	3
58	9.48920	9.97828	9.51091	10.48908	10.02171	10.51079	2
59	9.48959	9.97824	9.51134	10.48865	10.02174	10.51040	1
60	9.48998	9.07820	9.51177	10.48822	10.02179	10.51001	0
		Sine		Tang.		Secant.	M.

72 *Degrees.*

18 Degrees.

M	Sine		Tang.		Secant		
0	9.48998	9.97820	9.51177	10.48822	10.02179	10.51001	60
1	9.49037	9.97816	9.51220	10.48779	10.02183	10.50962	59
2	9.45075	9.97812	9.51263	10.48736	10.02187	10.50924	58
3	9.49114	9.97808	9.51306	10.48693	10.02191	10.50885	57
4	9.49153	9.97804	9.51349	10.48650	10.02195	10.50846	56
5	9.49192	9.97800	9.51392	10.48607	10.02199	10.50807	55
6	9.49230	9.97795	9.51434	10.48565	10.02204	10.50769	54
7	9.49269	9.97791	9.51477	10.48522	10.02208	10.50730	53
8	9.49308	9.97787	9.51520	10.48479	10.02212	10.50691	52
9	9.79346	9.97783	9.51562	10.48436	10.02216	10.50653	51
10	9.49385	9.97779	9.51605	10.48394	10.02220	10.50614	50
11	9.49423	9.97775	9.51648	10.48351	10.02224	10.50576	49
12	9.49462	9.97771	9.51691	10.48309	10.02228	10.50537	48
13	9.49500	9.97766	9.51733	10.48266	10.02233	10.50499	47
14	9.49538	9.97762	9.51776	10.48223	10.02237	10.50461	46
15	9.49577	9.97758	9.51818	10.48181	10.02241	10.50422	45
16	9.49615	9.97754	9.51861	10.48139	10.02245	10.50384	44
17	9.49653	9.97750	9.51903	10.48096	10.02249	10.50346	43
18	9.49691	9.97746	9.51945	10.48054	10.02253	10.50308	42
19	9.49730	9.97741	9.51988	10.48011	10.02258	10.50269	41
20	9.49768	9.97737	9.52030	10.47969	10.02262	10.50231	40
21	9.49806	9.97733	9.52072	10.47927	10.02266	10.50193	39
22	9.49844	9.97729	9.52115	10.47884	10.02270	10.50155	38
23	9.49882	9.97725	9.52157	10.47842	10.02274	10.50117	37
24	9.49920	9.97720	9.52199	10.47800	10.02279	10.50079	36
25	9.49958	9.97716	9.52241	10.47758	10.02283	10.50041	35
26	9.49996	9.97712	9.52283	10.47716	10.02287	10.50003	34
27	9.50034	9.97708	9.52325	10.47674	10.02291	10.49965	33
28	9.50072	9.97704	9.52367	10.47632	10.02295	10.49927	32
29	9.50109	9.97699	9.52410	10.47590	10.02300	10.49890	31
30	9.50147	9.97695	9.52452	10.47548	10.02304	10.49852	30
		Sin		Tang.		Secant	M.

71 Degrees.

18 *Degrees.*

M.	Sine		Tang.		Secant.		
30	9.50147	9.97695	9.52452	10.47548	10.02304	10.49852	30
31	9.50185	9.97691	9.52493	10.47506	10.02208	10.49814	29
32	9.50223	9.97687	9.52535	10.47454	10.02312	10.49776	28
33	9.5026	9.97683	9.52577	10.47422	10.02317	10.49739	27
34	9.50298	9.97678	9.52619	10.4738	10.02321	10.49701	26
35	9.50336	9.97674	9.52661	10.47338	10.02325	10.49664	25
36	9.50373	9.97670	9.52703	10.47296	10.02329	10.49626	24
37	9.50411	9.97666	9.52745	10.47254	10.02334	10.49588	23
38	9.50448	9.97661	9.52786	10.47213	10.02338	10.49551	22
39	9.50486	9.97657	9.52828	10.47171	10.02342	10.49514	21
40	9.50523	9.97653	9.52370	10.47129	10.02346	10.49476	20
41	9.50560	9.97648	9.52911	10.47088	10.02351	10.49439	19
42	9.50598	9.97644	9.52953	10.47046	10.02355	10.49401	18
43	9.50635	9.97640	9.52995	10.47004	10.02359	10.49364	17
44	9.50672	9.97636	9.53035	10.46963	10.02363	10.49327	16
45	9.50709	9.97631	9.53078	10.46921	10.02368	10.49290	15
46	9.50747	9.97627	9.53119	10.46880	10.02372	10.49252	14
47	9.50784	9.97623	9.53161	10.46838	10.02376	10.49215	13
48	9.50821	9.97618	9.53202	10.46797	10.02381	10.49178	12
49	9.50358	9.97614	9.53243	10.46756	10.02385	10.49141	11
50	9.50895	9.97610	9.53285	10.46714	10.02389	10.49104	10
51	9.50932	9.97606	9.53326	10.46673	10.02394	10.49067	9
52	9.50969	9.97601	9.53367	10.46632	10.02398	10.49030	8
53	9.51006	9.97597	9.53409	10.46590	10.02402	10.48993	7
54	9.51043	9.97593	9.53450	10.46549	10.02407	10.48956	6
55	9.51080	9.97588	9.53491	10.46508	10.02411	10.48919	5
56	9.51117	9.97584	9.53532	10.46467	10.02415	10.48882	4
57	9.51154	9.97580	9.53573	10.46426	10.02420	10.48846	3
58	9.5119	9.97575	9.53615	10.46384	10.02424	10.48809	2
59	9.51227	9.97571	9.53656	10.46343	10.02428	10.48772	1
60	9.51264	9.97567	9.53697	10.46302	10.02433	10.48735	0
		Sine.		Tangent.		Secant.	M.

71 *Degrees.*

19 *Degrees.*							
M	Sine		Tang.		Secant		
0	9.51264	9.97567	9.53697	10.46302	10.02433	10.48735	60
1	9.51300	9.97562	9.53738	10.46261	10.02437	10.48699	59
2	9.51337	9.97558	9.53779	10.46220	10.02441	10.48662	58
3	9.51374	9.97553	9.53820	10.46179	10.02446	10.48625	57
4	9.51410	9.97549	9.53861	10.46138	10.02450	10.48589	56
5	9.51447	9.97545	9.53902	10.46098	10.02454	10.48552	55
6	9.51483	9.97540	9.53942	10.46057	10.02459	10.48516	54
7	9.51520	9.97536	9.53983	10.46016	10.02463	10.48479	53
8	9.51556	9.97532	9.54024	10.45975	10.02467	10.48443	52
9	9.51593	9.97527	9.54065	10.45934	10.02472	10.48407	51
10	9.51629	9.97523	9.54106	10.45893	10.02476	10.48370	50
11	9.51665	9.97518	9.54146	10.45853	10.02481	10.48334	49
12	9.51702	9.97514	9.54187	10.45812	10.02485	10.48298	48
13	9.51738	9.97510	9.54228	10.45771	10.02489	10.48261	47
14	9.51774	9.97505	9.54268	10.45731	10.02494	10.48225	46
15	9.51810	9.97501	9.54309	10.45690	10.02498	10.48189	45
16	9.51846	9.97496	9.54349	10.45650	10.02503	10.48154	44
17	9.51882	9.97492	9.54390	10.45609	10.02507	10.48117	43
18	9.51919	9.97488	9.54431	10.45569	10.02512	10.48081	42
19	9.51955	9.97482	9.54471	10.45528	10.02516	10.48044	41
20	9.51991	9.97479	9.54511	10.45488	10.02520	10.48008	40
21	9.52027	9.97474	9.54552	10.45447	10.02525	10.47972	39
22	9.52063	9.97470	9.54592	10.45407	10.02529	10.47936	38
23	9.52099	9.97465	9.54633	10.45366	10.02534	10.47901	37
24	9.52134	9.97461	9.54673	10.45326	10.02538	10.47865	36
25	9.52170	9.97457	9.54713	10.45286	10.02543	10.47829	35
26	9.52206	9.97452	9.54754	10.45245	10.02547	10.47793	34
27	9.52242	9.97448	9.54794	10.45205	10.02551	10.47757	33
28	9.52278	9.97443	9.54834	10.45165	10.02556	10.47721	32
29	9.52313	9.97439	9.54874	10.45126	10.02560	10.47686	31
30	9.52349	9.97434	9.54814	10.45086	10.02565	10.47650	30
		Sine		Tang.		Secant	M.
70 *Degrees.*							

19 Degrees.

M	Sine		Tang.		Secant.		
30	9.52349	9.97434	9.54914	10.45085	10.02565	10.47650	30
31	9.52335	9.97430	9.54955	10.45045	10.0256[illegible]	10.47614	29
32	9.52420	9.97425	9.54995	10.45004	10.02574	10.47579	28
33	9.52456	9.97421	9.55035	10.44964	10.02578	10.47543	27
34	9.52492	9.97416	9.55075	10.44924	10.02583	10.47508	26
35	9.52527	9.97412	9.55115	10.44884	10.02587	10.47473	25
36	9.52563	9.97407	9.55155	10.44844	10.02592	10.47437	24
37	9.52598	9.97403	9.55195	10.44803	10.02596	10.47401	23
38	9.52633	9.97398	9.55235	10.44764	10.02601	10.47365	22
39	9.52669	9.97394	9.55275	10.44723	10.02605	10.47330	21
40	9.52704	9.97389	9.55314	10.44685	10.02610	10.47295	20
41	9.52740	9.97385	9.55354	10.44645	10.02614	10.47260	19
42	9.52775	9.97380	9.55394	10.44605	10.02619	10.47224	18
43	9.52810	9.97376	9.55434	10.44565	10.02623	10.47189	17
44	9.52845	9.97371	9.55474	10.44525	10.02628	10.47154	16
45	9.52881	9.97367	9.55513	10.44436	10.02632	10.47119	15
46	9.52916	9.97362	9.55553	10.44446	10.02637	10.47083	14
47	9.52951	9.97358	9.55593	10.44406	10.02642	10.47048	13
48	9.52986	9.97353	9.55632	10.44367	10.02646	10.47012	12
49	9.53021	9.97348	9.55672	10.44327	10.02651	10.46978	11
50	9.53056	9.97344	9.55712	10.44287	10.02655	10.46943	10
51	9.53091	9.97339	9.55751	10.44248	10.02660	10.46908	9
52	9.53126	9.97335	9.55791	10.44208	10.02564	10.46873	8
53	9.53161	9.97330	9.55830	10.44169	10.02669	10.46838	7
54	9.53196	9.97326	9.55870	10.4412[illegible]	10.02673	10.46803	6
55	9.53231	9.97321	9.55909	10.44[illegible]90	10.02678	10.46768	5
56	9.53266	9.97316	9.55949	10.44050	10.02683	10.46733	4
57	9.53300	9.97312	9.55988	10.4[illegible]011	10.02687	10.46699	3
58	9.53335	9.97307	9.56027	10.43972	10.02692	10.46664	2
59	9.53370	9.97302	9.56067	10.43932	0.02696	10.46629	1
60	9.53405	9.97398	9.56106	10.43893	10.02701	10.46591	0
		Sine.		Tangent.		Secant.	M

70 Degrees.

20 *Degrees.*

M.	Sine.		Tang.		Secant		
0	9.53405	9.97298	9.56106	10.43893	10.02701	10.46594	60
1	9.53439	9.97294	9.56145	10.43854	10.02706	10.46560	59
2	9.53474	9.97289	9.56185	10.43814	10.02710	10.46525	58
3	9.53509	9.97284	9.56224	10.43775	10.02715	10.46490	57
4	9.53543	9.97280	9.56263	10.43736	10.02719	10.46456	56
5	9.53578	9.97275	9.56302	10.43697	10.02724	10.46421	55
6	9.53612	9.97276	9.56341	10.43658	10.02729	10.46387	54
7	9.53647	9.97266	9.56381	10.43618	10.02733	10.46352	53
8	9.53681	9.97261	9.56420	10.43579	10.02738	10.46318	52
9	9.53716	9.97257	9.56459	10.43540	10.02742	10.46283	51
10	9.53750	9.97252	9.56498	10.43501	10.02747	10.46249	50
11	9.53785	9.97247	9.56537	10.43462	10.02752	10.46214	49
12	9.53819	9.97243	9.56576	10.43423	10.02756	10.46180	48
13	9.53853	9.97238	9.56615	10.43384	10.02761	10.46145	47
14	9.53888	9.97233	9.56654	10.43345	10.02766	10.46112	46
15	9.53922	9.97229	9.56693	10.43306	10.02770	10.46077	45
16	9.53956	9.97224	9.56732	10.43267	10.02775	10.49043	44
17	9.53990	9.97219	9.56770	10.43229	10.02780	10.46009	43
18	9.54024	9.97215	9.56809	10.43190	10.02784	10.45975	42
19	9.54059	9.97210	9.56848	10.43151	10.02789	10.45941	41
20	9.54093	9.97205	9.56887	10.43112	10.02794	10.45906	40
21	9.54127	9.97201	9.56926	10.43073	10.02798	10.45872	39
22	9.54161	9.97196	9.56964	10.43035	10.02803	10.45838	48
23	9.54195	9.97191	9.57003	10.42996	10.02808	10.45804	47
24	9.54229	9.97187	9.57042	10.42957	10.02813	10.45770	46
25	9.54263	9.97182	9.57080	10.42919	10.02818	10.45737	35
26	9.54297	9.97177	9.57119	10.42880	10.02822	10.45702	34
27	9.54331	9.97172	9.57158	10.42841	10.02827	10.45669	33
28	9.54364	9.97168	9.57196	10.42803	10.02831	10.45635	32
29	9.54398	9.97163	9.57235	10.42764	10.02836	10.45601	31
30	9.54432	9.97158	9.57273	10.42726	10.02841	10.45567	30
		Sine		Tang.		Secant	

69 *Degrees.*

20 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.54432	9.97158	9.57273	10.42726	10.02841	10.45567	30
31	9.54466	9.97154	9.57312	10.42687	10.02845	10.45533	29
32	9.54500	9.97149	9.57350	10.42649	10.02850	10.45499	28
33	9.54533	9.97144	9.57389	10.42610	10.02855	10.45465	27
34	9.54567	9.97139	9.57427	10.42572	10.02860	10.45432	26
35	9.54601	9.97135	9.57466	10.42534	10.02864	10.45398	25
36	9.54634	9.97130	9.57504	10.42495	10.02869	10.45365	24
37	9.54668	9.97125	9.57542	10.42457	10.02874	10.45331	23
38	9.54701	9.97120	9.57581	10.42419	10.02879	10.45298	22
39	9.54735	9.97116	9.57619	10.42380	10.02884	10.45264	21
40	9.54768	9.97111	9.57657	10.42342	10.02888	10.45231	20
41	9.54802	9.97106	9.57695	10.42301	10.02893	10.45197	19
42	9.54835	9.97101	9.57734	10.42265	10.02898	10.45164	18
43	9.54869	9.97097	9.57772	10.42227	10.02903	10.45130	17
44	9.54902	9.97092	9.57810	10.42180	10.02907	10.45097	16
45	9.54936	9.97087	9.57848	10.42151	10.02912	10.45064	15
46	9.54969	9.97082	9.57886	10.42113	10.02917	10.45030	14
47	9.55002	9.97077	9.57924	10.42075	10.02922	10.44997	13
48	9.55035	9.97073	9.57962	10.42037	10.02926	10.44964	12
49	9.55069	9.97068	9.58000	10.41999	10.02921	10.44930	11
50	9.55102	9.97063	9.58038	10.41961	10.02936	10.44897	10
51	9.55135	9.97058	9.58076	10.41923	10.02941	10.44865	9
52	9.55168	9.97053	9.58114	10.41885	10.02946	10.44831	8
53	9.55201	9.97049	9.58152	10.41847	10.02951	10.44798	7
54	9.55234	9.97044	9.58190	10.41809	10.02955	10.44765	6
55	9.55268	9.97039	9.58228	10.41771	10.02960	10.44732	5
56	9.55301	9.97034	9.58266	10.41733	10.02965	10.44698	4
57	9.55334	9.97029	9.58304	10.41695	10.02970	10.44665	3
58	9.55367	9.97024	9.58342	10.41657	10.02975	10.44533	2
59	9.55400	9.97020	9.58380	10.41620	10.02980	10.44600	1
60	9.55432	9.97014	9.58417	10.41582	10.02984	10.44567	0
		Sine		Tang		Secant	M.

69 *Degrees.*

21 *Degrees.*

M	Sine.		Tang.		Secant		
0	9.55432	9.97015	9.58417	10.41582	10.02984	10.44567	60
1	9.55465	9.97010	9.58455	10.41544	10.02989	10.44534	59
2	9.55498	9.97005	9.58493	10.41506	10.02994	10.44501	58
3	9.55531	9.97000	9.58530	10.41469	10.02999	10.44468	57
4	9.55564	9.96995	9.58568	10.41431	10.03004	10.44435	56
5	9.55597	9.96990	9.58606	10.41393	10.03009	10.44401	55
6	9.55629	9.96986	9.58643	10.41356	10.03014	10.44370	54
7	9.55662	9.96981	9.58681	10.41318	10.03018	10.44337	53
8	9.55695	9.96976	9.58719	10.41281	10.03023	10.44304	52
9	9.55728	9.96971	9.58756	10.41243	10.03028	10.44272	51
10	9.55760	9.96966	9.58794	10.41205	10.03033	10.44239	50
11	9.55793	9.96961	9.58831	10.41168	10.03038	10.44200	49
12	9.55825	9.96956	9.58869	10.41130	10.03043	10.44174	48
13	9.55858	9.96951	9.58906	10.41093	10.03049	10.44141	47
14	9.55890	9.96946	9.58944	10.41056	10.0305[illegible]	10.44109	46
15	9.55923	9.96942	9.58981	10.41018	10.03058	10.44076	45
16	9.55955	9.96937	9.59015	10.40981	10.0306[illegible]	10.44044	44
17	9.55988	9.96932	9.59056	10.40943	10.03067	10.4401[illegible]	43
18	9.56020	9.96927	9.59093	10.40906	10.0307[illegible]	10.43979	42
19	9.56053	9.96922	9.59130	10.40859	10.0307[illegible]	10.4394[illegible]	41
20	9.56085	9.96917	9.59168	10.40831	10.0308[illegible]	10.4391[illegible]	40
21	9.56117	9.96912	9.59205	10.40794	10.0308[illegible]	10.43882	39
22	9.56150	9.96907	9.59242	10.40757	10.0309[illegible]	10.4384[illegible]	38
23	9.56182	9.96902	9.59279	10.40720	10.0309[illegible]	10.43817	37
24	9.56214	9.96897	9.59317	10.40682	10.0310[illegible]	10.4378[illegible]	36
25	9.5624[illegible]	9.96892	9.59354	10.40645	10.03107	10.43753	35
26	9.56279	9.96887	9.59391	10.40608	10.0311[illegible]	10.43721	34
27	9.5631[illegible]	[illegible].96882	9.59428	10.40571	10.0311[illegible]	10.43688	33
28	9.56343	9.96877	9.59465	10.40534	10.0312[illegible]	10.43656	32
29	9.5637[illegible]	9.96872	9.59502	10.40497	10.0312[illegible]	10.43624	31
30	9.56407	9.96867	9.59539	10.40460	10.03132	10.43592	30
		Sine		Tang.		Secant	

68 *Degrees.*

21 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.56407	9.96867	9.59539	10.40460	10.03132	10.43592	30
31	9.56439	9.96862	9.59576	10.40423	10.03137	10.43560	29
32	9.56471	9.96857	9.59613	10.40386	10.03142	10.43528	28
33	9.56503	9.96852	9.59650	10.40349	10.03147	10.43496	27
34	9.56535	9.96847	9.59687	10.40312	10.03152	10.43464	26
35	9.56567	9.96842	9.59724	10.40275	10.03157	10.43432	25
36	9.56599	9.96837	9.59761	10.40238	10.03162	10.43400	24
37	9.56631	9.96832	9.59798	10.40201	10.03167	10.43368	23
38	9.56662	9.96827	9.59835	10.40164	10.03172	10.43336	22
39	9.56694	9.96822	9.59872	10.40127	10.03177	10.43304	21
40	9.56726	9.96817	9.59909	10.40090	10.03182	10.43273	20
41	9.56758	9.96812	9.59945	10.40054	10.03187	10.43241	19
42	9.56790	9.96807	9.59982	10.40017	10.03192	10.43209	18
43	9.56822	9.96802	9.60019	10.39980	10.03197	10.43177	17
44	9.56852	9.96797	9.60056	10.39943	10.03202	10.43146	16
45	9.56884	9.96792	9.60092	10.39907	10.03207	10.43114	15
46	9.56917	9.96787	9.60129	10.39870	10.03212	10.43082	14
47	9.56988	9.96782	9.60166	10.39833	10.03217	10.43051	13
48	9.56960	9.96777	9.60202	10.39797	10.03222	10.43019	12
49	9.57012	9.96772	9.60239	10.39760	10.03227	10.42988	11
50	9.57043	9.96767	9.60276	10.39723	10.03232	10.42956	10
51	9.57075	9.96762	9.60312	10.39687	10.03237	10.42924	9
52	9.57106	9.96757	9.60349	10.39650	10.03242	10.42893	8
53	9.57138	9.96752	9.90385	10.39614	10.03247	10.42862	7
54	9.57169	9.96747	9.60422	10.39577	10.03252	10.42830	6
55	9.57200	9.96742	9.60458	10.39541	10.03257	10.42799	5
56	9.57232	9.96737	9.60495	10.39504	10.03263	10.42767	4
57	9.55263	9.96731	9.60531	10.39468	10.03268	10.42736	3
58	9.57294	9.96726	9.60568	10.39431	10.03273	10.42705	2
59	9.57326	9.96721	9.60604	10.39395	10.03278	10.42673	1
60	0.57257	9.96716	9.60641	10.39359	10.03283	10.42642	0
		Sine		Tang.		Secant	M.

68 *Degrees.*

22 Degrees.							
M.	Sine.		Tang.		Secant		
0	9.57357	9.96716	9.60641	10.39359	10.03283	10.42642	60
1	9.57388	9.96711	9.60677	10.39322	10.03288	10.42611	59
2	9.57420	9.96706	9.60713	10.39286	10.03293	10.42580	58
3	9.57451	9.96701	9.60750	10.39250	10.03298	10.42548	57
4	9.57482	9.96695	9.60786	10.39213	10.03303	10.42517	56
5	9.57513	9.96691	9.60822	10.39177	10.03309	10.42486	55
6	9.57544	9.96685	9.60858	10.39141	10.03314	10.42455	54
7	9.57575	9.96680	9.60895	10.39105	10.03319	10.42424	53
8	9.57606	9.96675	9.60931	10.39068	10.03324	10.42393	52
9	9.57637	9.96670	9.60967	10.39032	10.03329	10.42362	51
10	9.57668	9.96665	9.61003	10.38996	10.03334	10.42331	50
11	9.57699	9.96660	9.61039	10.38960	10.03339	10.42300	49
12	9.57730	9.96655	9.61075	10.38924	10.03345	10.42269	48
13	9.57761	9.96649	9.61112	10.38888	10.03350	10.42238	47
14	9.57792	9.96644	9.61148	10.38852	10.03355	10.42207	46
15	9.57823	9.96639	9.61184	10.38815	10.03360	10.42176	45
16	9.57854	9.96634	9.61200	10.38779	10.03365	10.42145	44
17	9.57885	9.96629	9.61256	10.38743	10.03370	10.42114	43
18	9.57916	9.96624	9.61292	10.38707	10.03376	10.42083	42
19	9.57946	9.96618	9.61328	10.38671	10.03381	10.42053	41
20	9.57977	9.96613	9.61364	10.38635	10.03386	10.42023	40
21	9.58008	9.96608	9.61400	10.38600	10.03391	10.41991	39
22	9.58039	9.96603	9.61435	10.38564	10.03396	10.41960	38
23	9.58069	9.96598	9.61471	10.38528	10.03401	10.41930	37
24	9.58100	9.96592	9.61507	10.38492	10.03407	10.41899	36
25	9.58131	9.96587	9.61543	10.38456	10.03412	10.41868	35
26	9.58161	9.96582	9.61579	10.38420	10.03417	10.41838	34
27	9.58192	9.96577	9.61615	10.38384	10.03422	10.41807	33
28	9.58222	9.96572	9.61650	10.38349	10.03428	10.41777	32
29	9.58253	9.96566	9.61686	10.38313	10.03433	10.41746	31
30	9.58284	9.96561	9.61722	10.38277	10.03438	10.41716	30
		Sine		Tang.		Secant	M.
67 Degrees.							

22 *Degrees.*							
M.	Sine		Tang.		Secant		
30	9.58284	9.96561	9.61722	10.38277	10.03438	10.41716	30
31	9.58314	9.96556	9.61758	10.38241	10.03443	10.41685	29
32	9.58344	9.96551	9.61793	10.38206	10.03448	10.41655	28
33	9.58375	9.96545	9.61829	10.38170	10.03454	10.41624	27
34	9.58405	9.96540	9.61865	10.38134	10.03459	10.41594	26
35	9.58436	9.96535	9.61900	10.38099	10.03464	10.41563	25
36	9.58466	9.96530	9 61936	10.38063	10.03469	10.41533	24
37	9.58496	9.96524	9.61972	10.38027	10.03475	10.41503	23
38	9.58527	9.96519	9.62007	10.37992	10.03480	10 41472	22
39	9.58557	9.96514	9.62043	10.37956	10.03485	10.41442	21
40	9.58587	9.96509	9.62078	10.37921	10.03491	10.41412	20
41	9.58617	9.96503	9.6211.	10.37885	10.03496	10.41382	19
42	9.58648	9.96498	9.6214	10.37850	10.03501	10.41351	18
43	9.58678	9.96493	9.62185	10.37814	10.03506	10.4132	17
44	9.58708	9.96487	9.62220	10.37779	10.03512	10.41291	16
45	9.58738	9.96482	9.62256	10.37743	10.03517	10.41261	15
46	9.58768	9.96477	9.62291	10.37708	10.03522	10.41231	14
47	9.58798	9.96471	9.62326	10.37673	10.03528	10.41201	13
48	9.58828	9.96466	9.62362	10.37637	10.03533	10.41171	12
49	9.58859	9.96461	9.62397	10.37602	10.03538	10.41141	11
50	9.58889	9.96456	9.62433	10.37567	10.03544	10.4111	10
51	9.58919	9.96450	9.62468	10.37531	10.03349	10.41081	9
52	9.58948	9.96445	9.62503	10.37496	10.03554	10.41051	8
53	9.58978	9.96440	9.62538	10.37461	10.03560	10.41021	7
54	9.59008	9.96434	9.62574	10.37425	10.0356	10.40991	6
55	9.59038	9.96429	9.62600	10.37390	10.03570	10.40961	5
56	9.55068	9.96424	9 62644	10.37355	10.03576	10.40931	4
57	9.59098	9.96418	9.62679	10.3732	10.03581	10.40901	3
58	9.59128	9.96413	9.62714	10.37285	10.03586	10.40871	2
59	9.59158	9.96408	9.62750	10.37249	10.03592	10.40842	1
60	9.59187	9.96402	9.62785	10.37214	10.03597	10.40812	0
		Sine		Tang.		Secant	M.
67 *Degrees.*							

23 Degrees.							
M.	Sine.		Tang.		Secant		
0	9.59187	9.96402	9.62785	10.37214	10.03597	10.40812	60
1	9.59217	9.96397	9.62820	10.37179	10.03602	10.40782	59
2	9.59247	9.96391	9.62855	10.37144	10.03608	10.40752	58
3	9.59277	9.96386	9.62890	10.37109	10.03613	10.40723	57
4	9.59305	9.96381	9.62925	10.37074	10.03618	10.40693	56
5	9.59336	9.96375	9.62960	10.37039	10.03624	10.40663	55
6	9.59365	9.96370	.62995	10.37004	10.03629	10.40634	54
7	9.59395	9.96365	9.63030	10.36969	10.03635	10.40604	53
8	9.59425	9.96359	9.63065	10.36934	10.03640	10.40574	52
9	9.59454	9.96354	9.63100	10.36899	10.03645	10.40545	51
10	9.59484	9.96348	9.63135	10.36864	10.03651	10.40515	50
11	9.59513	9.96343	9.63170	10.36829	10.03656	10.40486	49
12	9.59543	9.96337	9.63205	10.36794	10.03662	10.40456	48
13	9.59572	9.96332	9.63240	10.36759	10.03667	10.40427	47
14	9.59602	9.96327	9.63275	10.36725	10.03672	10.40397	46
15	9.59631	9.96321	9.63309	10.36690	10.03678	10.40368	45
16	9.59660	9.96316	9.63344	10.36655	10.03683	10.40339	44
17	9.59690	9.96310	9.63379	10.36620	10.03689	10.40300	43
18	9.59719	9.96305	9.63414	10.36585	10.03594	10.40280	42
19	9.59749	9.9629	9.63449	10.36551	10.03700	10.40251	41
20	9.59778	9.96294	9.63483	10.36516	10.03705	10.40221	40
21	9.59807	9.96289	9.63518	10.36481	10.03711	10.40192	39
22	9.59836	9.96283	9.63553	10.36446	10.03716	10.40163	38
23	9.59866	9.96278	9.63587	10.36412	10.03721	10.40134	37
24	9.59895	9.96272	9.63622	10.36377	10.03727	10.40104	36
25	9.59924	9.96267	9.63657	10.36342	10.03732	10.40075	35
26	9.59953	9.96261	9.63691	10.36308	10.03738	10.40046	34
27	9.59982	9.96256	9.63726	10.36273	10.03743	10.40017	33
28	9.60011	9.96250	9.63761	10.36238	10.03749	10.39988	32
29	9.60040	9.9624	9.63795	10.36204	10.03754	10.39959	31
30	9.60070	9.96239	9.63830	10.36169	10.03760	10.39930	30
		Sine		Tang.		Secant	M
66 Degrees.							

23 Degrees.							
M.	Sine		Tang.		Secant		
30	9.60070	9.9623	9.63830	10.36169	10.03760	10.39930	30
31	9.60099	9.96234	9.63864	10.36135	10.03765	10.39901	29
32	9.60128	9.96228	9.63899	10.36100	10.03771	10.39872	28
33	9.60157	9.96223	9.63933	10.36 66	10.0377	10.39843	27
34	9.60186	9.96217	9.63068	10.36 3	10.03782	10.3981	26
35	9.60214	9.96212	9.64002	10.35997	10.03787	10.3978	25
36	9.60243	9.96206	9.64037	10.35962	10.03793	10.39756	24
37	9.60272	9.96201	9.64 71	10.35928	10.03798	10.39727	23
38	9.60301	9.961 5	.64106	10.35894	10.03804	10.39698	22
39	9.6033	9.9619	9.64140	10.35859	10.03809	10.39669	21
40	9.603 9	9.9618	9.64174	10.35825	10.03815	10.39640	20
41	9.60388	9.96179	9.6420	10.35790	10.03820	10.39611	19
42	9.6 417	9.96173	9.64243	10.35756	10.03826	10.39583	18
43	9.60445	9.96168	9.64277	10.35722	10.03832	10.3955	17
44	9.60474	9.96162	9.64312	10.35688	10.03837	10.39525	16
45	9.60503	9.96156	9.64346	10.35653	10.03843	10.39496	15
46	9.60531	9.961 1	9.64380	10.35619	10.03848	10.39468	14
47	9.60560	9.96145	9.64414	10.35585	10.0385	10.39439	13
48	9.60589	9.96140	9.6444	10.35551	10.038	10.39410	12
49	9.60617	9.9613	9.6448	10.35 16	10.0386	10.39382	11
50	9.6 646	9.96129	9.64517	10.35482	10.03871	10.39352	10
51	9.60675	9.96123	9.6455	10.35448	10.0387	10.37324	9
52	9.607 3	9.96117	9.6458	10.35414	10.03882	10.3 29	8
53	9.60732	9.96112	9.6461	10.35380	10.0388	10.3 26	7
54	9.60760	9.06106	9.6465	10.35346	10.03893	10.3 23	6
55	9.60789	9.96101	9.6468	10.3531	10.03898	10.3921	5
56	9.6 817	9.96 95	9.64722	10.35277	10.03904	10.39182	4
57	9.60846	9.9608	9.64756	10.352 3	10.03910	10.39153	3
58	9.60874	9.96084	9. 790	10.35209	10.03915	10.3912	2
59	9.60902	9.96078	9.64824	10.35175	10.03921	10.39097	1
60	9.60931	9.96073	9.64858	10.35141	10.03 27	10.3906	0
		Sine		Tang		Secant	M
65 Degrees.							

24 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.609[illegible]1	9.96073	9.64858	10.35141	10.03927	10.39068	60
1	9.6095[illegible]	9.96[illegible]67	9.6489[illegible]	10.35107	10.03932	10.39040	59
2	9.60988	9.96061	[illegible].64926	10.35073	10.03938	10.39012	58
3	9.61016	9.96056	9.6496	10.35039	10.03943	10.38983	57
4	9.6104[illegible]	9.96050	9.64[illegible]94	10.35005	10.03949	10.38[illegible]55	56
5	9.610[illegible]7[illegible]	9.96044	[illegible].65028	10.34[illegible]71	10.03955	10.38927	55
6	9.61101	9.96039	9.65062	10.34938	10.03[illegible]6[illegible]	10.38898	54
7	9.6112[illegible]	9.96033	9.65095	10.34[illegible]04	10.03966	10.3[illegible]8[illegible]0	53
8	9.61157	9.96027	9.65129	10.34870	10.03[illegible]72	10.38842	52
9	9.6118[illegible]	9.96022	9.65163	10.34836	10.03[illegible]77	10.38814	51
10	9.6121[illegible]	9.9601[illegible]	9.651[illegible]	10.34802	10.0398[illegible]	10.38[illegible]86	50
11	9.61242	9.9601[illegible]	9.65231	10.34768	10.03989	10.38[illegible]57	49
12	9.6127[illegible]	9.96005	9.6526[illegible]	10.34735	10.0399[illegible]	10.38[illegible]29	48
13	9.61298	9.95999	9.65298	10.34701	10.0400[illegible]	10.38701	47
14	9.61326	9.9599[illegible]	9.6533[illegible]	10.34[illegible]67	10.04006	10.38[illegible]	46
15	9.6135[illegible]	9.9598	9.65366	10.34[illegible]33	10.040[illegible]1	10.38645	45
16	9.61382	9.95982	9.65400	10.34600	10.04017	10.38617	44
17	9.61410	9.95976	9.6543[illegible]	10.34566	10.0402[illegible]	10.38589	43
18	9.61438	9.95971	9.65467	10.34532	10.04028	10.38561	42
19	9.61466	9.95965	9.65501	10.34498	10.040[illegible]	10.38533	41
20	9.61494	9.95959	9.65534	10.34464	10.04040	10.38505	40
21	9.61522	9.95953	9.65568	10.34431	10.04046	10.38477	39
22	9.61550	9.95948	9.65602	10.34398	10.04051	10.38449	38
23	9.61578	9.95942	9.65635	10.34364	10.04057	10.38421	37
24	9.61606	9.95936	9.656[illegible]	10.34330	10.0406[illegible]	10.38394	36
25	9.61633	9.95931	9.657[illegible]2	10.34297	[illegible]4[illegible]69	10.38366	35
26	9.61661	9.95925	9.65730	10.3426[illegible]	10.04074	10.38338	34
27	9.61689	9.95919	9.6576[illegible]	10.3[illegible]23	10.04080	10.38310	33
28	9.61717	9.95913	9.6580[illegible]	[illegible].3419	10.04086	10.38282	32
29	9.6174[illegible]	9.95908	9.6583[illegible]	10.3416[illegible]	10.04091	10.38255	31
30	9.61772	9.95[illegible]02	9.6[illegible]8[illegible]0	10.3412[illegible]	10.04097	10.38227	30
		Sine		Tang.		Secant	M.

65 *Degrees.*

24 *Degrees.*

M.	Sine.		Tang.		Secant.		
30	9.61772	9.95902	9.65870	10.34129	10.04097	10.38227	30
31	9.61800	9.95896	9.65903	10.34096	10.04103	10.38199	29
32	9.61828	9.95890	9.65937	10.34062	10.0410	10.38171	28
33	9.61855	9.95885	9.65970	10.34029	10.04115	10.38144	27
34	9.61883	9.95879	9.66004	10.33995	10.04120	10.38116	26
35	9.61911	9.95873	9.66037	10.33962	10.04126	10.38089	25
36	9.61938	9.95867	9.66071	10.33929	10.04132	10.38061	24
37	9.61966	9.95861	9.66104	10.33895	10.04138	10.38033	23
38	9.61993	9.95855	9.66137	10.33862	10.04148	10.38006	22
39	9.62021	9.95850	9.66171	10.33829	10.04149	10.37978	21
40	9.62048	9.95844	9.66204	10.33795	10.04155	10.37951	20
41	9.62076	9.95838	9.66237	10.33762	10.04161	10.37923	19
42	9.62103	9.95832	9.66270	10.33729	10.04167	10.37896	18
43	9.62131	9.95827	9.66304	10.33695	10.04172	0.37868	17
44	9.62158	9.95821	9.66337	10.33662	10.04178	10.37841	16
45	9.62186	9.95815	9.66370	10.33629	10.04184	10.37813	15
46	9.62213	9.95809	9.66403	10.33596	10.04190	10.37786	14
47	9.62240	9.95803	9.66437	10.33562	10.04196	10.37759	13
48	9.62268	9.95797	9.66470	10.33529	10.04202	10.37731	12
49	9.62295	9.95792	9.66503	10.33496	10.04207	10.37704	11
50	9.62322	9.95786	9.66536	10.33463	10.04213	10.3767	10
51	9.62350	9.95780	9.66569	10.33430	10.04219	10.37649	9
52	9.62377	9.95774	9.66602	10.33397	10.0422	10.37622	8
53	9.62404	9.95758	9.66636	10.33364	10.04231	10.37595	7
54	9.62431	9.95762	9.66669	10.33330	10.04237	10.37568	6
55	9.62458	9.95757	9.66702	10.33297	10.04242	10.37540	5
56	9.62485	9.95751	9.66735	10.33264	10.04248	10.37513	4
57	9.62513	9.95745	9.66768	10.33231	10.04254	10.37486	3
58	9.62540	9.95739	9.66801	10.33198	10.04260	10.37459	2
59	9.62567	9.95733	9.66834	10.33165	10.04266	10.37432	1
60	9.62594	9.95727	9.66867	10.33132	10.04272	10.37405	0
		Sine.		Tang.		Secant.	M.

65 *Degrees.*

25 *Degrees.*

M.	Sine.		Tang		Secant.		
0	9.62594	9.95727	9.66867	10.33132	10.04272	10.37405	60
1	9.62621	9.95721	9.66900	10.33099	10.04278	10.37378	59
2	9.62649	9.95715	9.66933	10.33066	10.04284	10.37351	58
3	9.62676	9.95709	9.66966	10.33033	10.04290	10.37324	57
4	9.62703	9.95704	9.66999	10.33000	10.04296	10.37297	56
5	9.62730	9.95698	9.67032	10.32968	10.04301	10.37270	55
6	9.62757	9.95692	9.67064	10.32935	10.04307	10.37243	54
7	9.62784	9.95686	9.67097	10.32902	10.04313	10.37216	53
8	9.62810	9.95680	9.67130	10.32869	10.04319	10.37189	52
9	9.62837	9.95674	9.67163	10.32836	10.04325	10.27162	51
10	9.62864	9.95668	9.67196	10.32803	10.04331	10.37135	50
11	9.62891	9.95662	9.67229	10.32770	10.04337	10.37108	49
12	9.62918	9.95656	9.67261	10.32738	10.04343	10.37081	48
13	9.62945	9.95650	9.67294	10.32705	10.04349	10.37054	47
14	9.62972	9.95644	9.67327	10.32672	10.04355	10.37027	46
15	9.62998	9.95638	9.67360	10.32639	10.04361	10.37001	45
16	9.63025	9.95632	9.67392	10.32607	10.04367	10.36974	44
17	9.63052	9.95626	9.67425	10.32574	10.04373	10.36947	43
18	9.63079	9.95620	9.67458	10.32541	10.04379	10.36920	42
19	9.63105	9.95614	9.67491	10.32508	10.04385	10.36893	41
20	9.63132	9.95608	9.67523	10.32476	10.04391	10.36867	40
21	9.63159	9.95602	9.67556	10.32443	10.04397	10.36840	39
22	9.63185	9.95596	9.67589	10.32411	10.04403	10.36814	38
23	9.63212	9.95590	9.67621	10.32378	10.04409	10.36787	37
24	9.63239	9.95584	9.67654	10.32345	10.04415	10.36760	36
25	9.63265	9.95578	9.67686	10.32313	10.04421	10.36734	35
26	9.63292	9.95572	9.67719	10.32280	10.04427	10.36707	34
27	9.63318	9.95566	9.67752	10.32248	10.04433	10.36681	33
28	9.63345	9.95560	9.67784	10.32215	10.04439	10.36654	32
29	9.63371	9.95554	9.67817	10.32182	10.04445	10.36528	31
30	9.63398	9.95538	9.67849	10.32150	10.04451	10.26601	30
		Sine.		Tang.		Secant.	

64 *Degrees.*

25 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.63398	9.95548	9.67849	10.32150	10. 4451	10.36001	30
31	9.63424	9.95542	9.67882	10.32117	10. 4457	10.36575	29
32	9.63451	9.95536	9.67914	10.32085	10. 4463	10.36548	28
33	9.63477	9.95530	9.67947	10.32052	10. 4469	10.36522	27
34	9.63504	9.95524	9.67979	10.32020	10. 4475	10.36495	26
35	9.63531	9.95518	9.68012	10.31988	10.04481	10.36469	25
36	9.63557	9.95512	9.68044	10.31955	10.04487	10.36443	24
37	9.63583	9.95506	9.63076	10.31923	10.04493	10.36416	23
38	9.63600	9.95500	9.68109	10.31890	10.04499	10.36390	22
39	9.63636	9.95494	9.68141	10.31858	10.04505	10.36264	21
40	9.63662	9.95488	9.68174	10.31820	10.04511	10.36337	20
41	9.63688	9.95482	9.682 6	10.31793	10.04517	10.36311	19
42	9.63715	9.95476	9.68238	10.31761	10.04523	10.36285	18
43	9.63741	9.95470	9.68271	10.31729	10.04529	10.36258	17
44	9.63767	9.95464	9.68303	10.33696	10.04535	10.36232	16
45	9.63794	9.95457	9.68335	10.31664	10.04542	10.36206	15
46	9.63819	9.95451	9.68367	10.31632	10.04548	10.36180	14
47	9.63845	9.95445	9.68400	10.31599	10.04554	10.36154	13
48	9.63872	9.95439	9.68432	10.31567	10.04560	00.36128	12
49	9.63898	9.95433	9.68464	10.31535	10.04566	10.36101	11
50	9.63924	9.95427	9.68496	10.31503	10.04572	10.36075	10
51	9.63950	9.95421	9.68529	10.31471	10.04578	10.36049	9
52	9.63975	9.95415	9.68561	10.31438	10.04584	10.36022	8
53	9.64002	9.95409	9.68593	10.31406	10.04591	10.35997	7
54	9.64028	9.95402	9.68625	10.31374	10.04597	10.35971	6
55	9.64054	9.95396	9.68657	10.31342	10.04603	10.35945	5
56	9.64080	9.95390	9.68689	10.31310	10.04609	10.35919	4
57	9.64106	9.95384	9.68721	10.31278	10.04615	10.35893	3
58	9.64132	9.95378	9.68754	10.31246	10.04621	10.35867	2
59	9.64158	9.95372	9.68785	10.31213	10.04627	10.35841	1
60	9.64184	9.95366	9.68818	10.31181	10.04624	10.35815	0
		Sine		Tang.		Secant.	M

64 *Degrees.*

26 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.64184	9.95366	9.68818	10.31181	10.04634	10.35815	60
1	9.64210	9.95359	9.68850	10.31149	10.04640	10.35789	59
2	9.64236	9.95353	9.68882	10.31117	10.04645	10.35764	58
3	9.64261	9.95347	9.68914	10.31085	10.04652	10.35738	57
4	9.64287	9.95341	9.68946	10.31053	10.04658	10.35712	56
5	9.64313	9.95335	9.68978	10.31021	10.04664	10.35686	55
6	9.64339	9.95329	9.69010	10.30989	10.04671	10.35660	54
7	9.64365	9.95322	9.69042	10.30957	10.04677	10.35635	53
8	9.64390	9.95316	9.69074	10.30925	10.04683	10.35609	52
9	9.64416	9.95310	9.69106	10.30893	10.04689	10.35583	51
10	9.64442	9.95304	9.69138	10.30861	10.04695	10.35557	50
11	9.64468	9.95298	9.69170	10.3083	10.04702	10.35532	49
12	9.64493	9.95291	9.69201	10.30798	10.04708	10.35506	48
13	9.64519	9.95285	9.69233	10.30766	10.04714	10.35480	47
14	9.64545	9.95279	9.69265	10.30734	10.04720	10.35455	46
15	9.64570	9.95273	9.69297	10.30702	10.04726	10.35429	45
16	9.64596	9.95266	9.69329	10.30670	10.04733	10.35403	44
17	9.64621	9.95260	9.66361	10.30638	10.04739	10.35378	43
18	9.64647	9.95254	9.69393	10.30607	10.04745	10.35352	42
19	9.64672	9.95218	9.69424	10.30575	10.04751	10.35327	41
20	9.64698	9.95241	9.69456	10.30543	10.04758	10.35301	40
21	9.64723	9.95235	9.69488	10.30511	10.04764	10.35276	39
22	9.64749	9.95229	9.69520	10.30479	10.04770	10.35250	38
23	9.64774	9.95223	9.69551	10.30448	10.04776	10.35225	37
24	9.64800	9.95216	9.69583	10.30416	10.04782	10.35199	36
25	9.64825	9.95210	9.69615	10.30384	10.04789	10.35174	35
26	9.64851	9.95204	9.69647	10.30353	10.04795	10.35148	34
27	9.64876	9.95198	9.69678	10.30321	10.04802	10.35123	33
28	9.64902	9.95191	9.69710	10.30289	10.04808	10.35098	32
29	9.64927	9.95183	9.69742	10.30258	10.04814	10.35072	31
30	9.64952	9.95179	9.69773	10.30226	10.04820	10.35047	30
		Sine		Tang.		Secant.	

63 *Degrees.*

26 Degrees.							
M.	Sine.		Tang.		Secant		
30	9.64952	9.95179	9.69773	10.30226	10.04820	10 35047	30
31	9.64978	9.95172	9.69805	10.301[illegible]	10.04827	10.35021	29
32	9.65-03	9.95156	9.69836	10.3[illegible]16[illegible]	0.04833	10.34996	28
33	9.65028	.9516	9.69868	10.3-13	10.04[illegible]9	10.34971	27
34	9.65053	9.951[illegible]	9.69900	10.3009[illegible]	10.04846	10.34946	26
35	9.65079	9.95147	9.69931	10.30001	10.04852	10.34920	25
36	9.65104	9.95141	9.69963	10.3003	10.04858	10.34895	24
37	9.6512	9.95134	9.6999[illegible]	10.3000[illegible]	10.04855	10.34870	23
38	9.651[illegible]4	9.95128	9.70-26	10.29973	10.04871	10.34845	22
39	9.6518	9.95122	9.70057	10.29[illegible]42	10.04877	10.34820	21
40	9.65205	9.95115	9.70089	10.29910	10.04884	10.34794	20
41	9.65230	9.95109	9.7012	10.29879	10.04890	10.34769	19
42	9.65255	9.95103	.70152	10.29847	10.04896	10.34744	18
43	9.65280	9.95096	9.70183	10.2981	10 04903	10.34719	17
44	9.65305	9.95090	9.70215	10.29784	10.04929	10.34694	16
45	9.65330	9.95084	9.70246	10.2975	10.04915	10 34669	15
46	9.65355	9.95077	9.70278	10 29721	10.04922	10.34644	14
47	9.6538	9.95071	9 70309	10.2969	10.04928	10.34619	13
48	9.65405	9 95065	9.70340	10.29659	10.04935	10.34594	12
49	9.65430	.95058	9.70372	10.29627	10 04941	10.34569	11
50	9.65455	.95052	9.70403	10.29596	10.04947	10.34544	10
51	9.65480	9.9504[illegible]	9 70435	10.29565	10.04954	10.34519	9
52	9.65505	9.95039	9.70466	10.2953	10 04960	10.34494	8
53	9.65530	9 95033	9.70497	10.29502	10.04967	10.34469	7
54	9.655[illegible]	9.95027	9.70529	10.2947	10.04973	10 34444	6
55	9.6558[illegible]	.95020	9.70560	10.29439	10.04979	10.34419	5
56	9.656 5	9.95013	9.70591	10.29408	10.04986	10.34394	4
57	9.65630	9.95007	9.70622	10.2937	10.04992	10.34369	3
58	9.65655	9.95000	9.70654	10.29345	10.04999	10.34344	2
59	9.65679	9.94994	9.70685	10.29314	10.05005	00.34320	1
60	9.65704	9.94988	9.70716	10.29283	10.05011	10.31295	0
		Sine		Tang.		Secant	M.
63 Degrees.							

27 *Degrees.*

M.	Sine.		Tang.		Secant		
0	9.65704	9.94988	9.70716	10.29283	10.05011	10.34295	60
1	9.65729	9.94981	9.70747	10.29252	10.05018	10.34271	59
2	9.65754	9.94975	9.70779	10.29221	10.05024	10.33245	58
3	9.65779	9.94968	9.70810	10.2918[illegible]	10.05031	10.34221	57
4	9.65803	9.94962	9.70841	10.29158	10.05037	10.34196	56
5	9.65828	9.94955	9.70872	10.29127	10.05044	10.34171	55
6	9.65853	9.94949	9.70903	10.29096	10.05050	10.34146	54
7	9.65877	9.94942	9.70934	10.29065	10.05057	10.34122	53
8	9.65902	9.94936	9.70966	10.29034	10.05063	10.34097	52
9	9.65927	9.94930	9.70997	10.29002	10.05070	10.34072	51
10	9.65951	9.94923	9.71028	10.28971	10.05070	10.34048	50
11	9.65976	9.94917	9.71059	10.28940	10.05083	10.34023	49
12	9.66000	9.94910	9.71090	10.28909	10.05089	10.33999	48
13	9.66025	9.94904	9.71121	10.28878	10.05096	10.33974	47
14	9.66050	9.94897	9.71152	10.28847	10.05102	10.33949	46
15	9.66074	9.94891	9.71183	10.28816	10.05109	10.33925	45
16	9.66099	9.94884	9.71214	10.28785	10.05115	10.33900	44
17	9.66123	9.94878	9.71245	10.28754	10.05122	10.33876	43
18	9.69148	9.94871	9.71276	10.28723	10.05128	10.33851	42
19	9.66172	9.94864	9.71307	10.28692	10.05135	10.33827	41
20	9.66197	9.94858	9.71338	10.28661	10.05141	10.33803	40
21	9.66221	9.94851	9.71369	10.28630	10.05148	10.33778	39
22	9.66245	9.94845	9.71400	10.28599	10.05154	10.33754	38
23	9.66270	9.94838	9.71431	10.28568	10.05161	10.3372	37
24	9.66294	9.64832	9.71462	10.28537	10.05167	10.33705	36
25	9.66319	9.94825	9.71493	10.28506	10.05174	10.33681	35
26	9.66343	9.94819	9.71524	10.28476	10.05180	10.33656	34
27	9.66367	9.94812	9.71555	10.28444	10.05187	10.33632	33
28	9.66392	9.94806	9.71585	10.28414	10.05194	10.33608	32
29	9.66416	9.94799	9.71616	10.28383	10.05200	00.33583	31
30	9.66440	9.94792	9.71647	10.28352	10.05207	10.33559	30
		Sine		Tang.		Secant	

62 *Degrees.*

27 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.66440	9.94792	9.71647	10.28352	10.05207	10.33559	30
31	9.66464	9.94786	9.71678	10.28321	10.05213	10.33535	29
32	9.66489	9.94779	9.71709	10.28290	10.05220	10.33510	28
33	9.66513	9.94773	9.71740	10.28259	10.05226	10.33486	27
34	9.66537	9.94766	9.71770	10.82[illegible]9	10.05233	10.33462	26
35	9.66561	9.94759	9.71801	10.28198	10.05240	10.33438	25
36	9.66585	9.94753	9.71832	10.28167	10.05246	10.33414	24
37	9.66610	9.94746	9.71864	10.28136	10.05253	10.33390	23
38	9.66634	9.94740	9.71894	10.28106	10.0525	10.33365	22
39	9.66658	9.947[illegible]3	9.71924	10.28075	10.05266	10.33341	21
40	9.66682	9.96726	9.71955	10.28044	10.05273	10.33317	20
41	9.66706	9.96720	9.71986	10.28013	10.05279	10.33293	19
42	9.66730	9.96713	9.72016	10.27983	10.05286	10.33269	18
43	9.66754	9.96707	9.72047	10.27952	10.05293	10.33245	17
44	9.66778	9.96[illegible]00	9.720[illegible]8	10.27921	10.05299	10.33221	16
45	9.66802	9.94693	9.72108	10.27891	10.05306	10.33197	15
46	9.66826	9.94687	9.72139	10.27860	10.05312	10.33173	14
47	9.66850	9.94680	9.72170	10.27829	10.05319	10.33149	13
48	9.66874	9.94673	9.72200	10.27799	10.05326	10.33125	12
49	9.66898	9.94667	9.72231	10.27768	10.05332	10.33101	11
50	9.66922	9.94660	9.72262	10.27737	10.0533[illegible]	10.33077	10
51	9.66946	9.94653	9.72292	10.27707	10.05346	10.33053	9
52	9.66970	9.94647	9.72323	10.27676	10.05352	10.33029	8
53	9.66994	9.94640	9.72353	10.27646	10.05359	10.33005	7
54	9.67018	9.94632	9.72384	10.27615	10.0536[illegible]	10.32981	6
55	9.67041	9.94627	9.72414	10.27585	10.0537[illegible]	10.32958	5
56	9.67065	9.94620	9.72445	10.27554	10.0537[illegible]	10.32934	4
57	9.67089	9.94613	9.72475	10.27524	10.05386	10.32910	3
58	9.67113	9.9460[illegible]	9.72506	10.27493	10.05392	10.32886	2
59	9.67137	9.94600	9.72536	10.27463	10.05399	10.32862	1
60	9.67160	9.9159[illegible]	9.72567	10.27432	10.05406	10.32839	0
		Sine.		Tang.		Secant	M.

62 *Degrees.*

28 Degrees.

M.	Sine		Tang.		Secant		
0	9.67160	9.94593	9.72567	10.27432	10.05407	10.32839	60
1	9.67184	9.94586	9.72597	10.27402	10.05413	10.32815	59
2	9.67208	9.94580	9.72628	10.27371	10.05419	10.32791	58
3	9.67232	9.94573	9.72658	10.27341	10.05426	10.32767	57
4	9.67256	9.94566	9.72689	10.27310	10.05433	10.32744	56
5	9.67279	9.94559	9.72719	10.27280	10.05440	0.32720	55
6	9.67303	9.94553	9.72750	10.27249	10.05446	0.32696	54
7	9.67326	9.94546	9.72780	10.27219	10.05453	10.32673	53
8	9.67350	9.94539	9.72810	10.27188	10.05460	10.32649	52
9	9.67374	9.94532	9.72841	10.27158	10.05467	10.32625	51
10	9.67397	9.94526	9.72871	10.27128	10.05474	10.32602	50
11	9.67421	9.94519	9.72902	10.27098	10.05480	10.32578	49
12	9.67444	9.94512	9.72932	10.27067	10.05487	10.32555	48
13	9.67468	9.94505	9.72962	10.27037	10.05494	10.32531	47
14	9.67491	9.94499	9.72992	10.27007	10.05501	10.32508	46
15	9.67515	9.94492	9.73023	10.26976	10.05507	10.32484	45
16	9.67538	9.94485	9.73053	10.26946	10.05514	10.32461	44
17	9.67562	9.94478	9.73083	10.26916	10.05521	10.32437	43
18	9.67585	9.94471	9.73114	10.26885	10.05528	10.32414	42
19	9.67609	9.94465	9.73144	10.86855	10.05535	10.22390	41
20	9.97632	9.94458	9.73174	10.26825	10.05541	10.32367	40
21	9.67656	9.94451	9.73204	10.26795	10.05548	10.32343	39
22	9.67679	9.94444	9.73235	10.26764	10.05555	10.32320	38
23	9.67703	9.94437	9.73265	10.26734	10.05562	10.32297	37
24	9.67726	9.94430	9.73295	10.26704	10.05569	10.32273	36
25	9.67749	9.94424	9.73325	10.26674	10.0557	10.32250	35
26	9.67773	9.94417	9.73355	10.26644	10.05582	10.32226	34
27	9.67796	9.94410	9.73386	10.26614	10.05589	10.32203	33
28	9.67819	9.94403	9.73416	10.26583	10.05596	10.32180	32
29	9.67843	9.94396	9.73446	10.26553	10.05603	10.32157	31
30	9.67866	9.94389	9.73476	10.26523	10.05610	10.32133	30
		Sine.		Tang.		Secant	

61 Degrees.

28 *Degrees.*

M.	Sin (		Tang.		Secant		
30	9.67866	9.94389	9.73476	10.26523	10.05610	10.32133	30
31	9.67889	9.94383	9.73506	10.26493	10.05617	10.32110	29
32	9.67912	9.94376	9.73536	10.26463	10.05623	10.32087	28
33	9.67936	9.94369	9.73596	10.26433	10.05630	10.32064	27
34	9.67959	9.94362	9.73696	10.26403	10.05637	10.31040	26
35	9.67982	9.94355	9.73626	10.26373	10.05644	10.32017	25
36	9.68005	9.94348	9.73657	10.26343	10.05651	10.31994	24
37	9.68028	9.9434	9.73687	10.26312	10.05658	10.31971	23
38	9.68051	9.94334	9.73717	10.26282	10.05665	10.31948	22
39	9.68075	9.94327	9.73747	10.26252	10.05672	10.31925	21
40	9.68098	9.94321	9.73777	10.26222	10.05679	10.31901	20
41	9.68121	9.94314	9.73807	10.26192	10.05685	10.31878	19
42	9.68144	9.94307	9.73837	10.26162	10.05692	10.31855	18
43	9.68167	9.94300	9.73867	10.26132	10.05699	10.31832	17
44	9.68190	9.94293	9.73897	10.26102	10.05706	10.31809	16
45	9.68213	9.94286	9.73927	10.26072	10.05713	10.31786	15
46	9.68236	9.94279	9.73957	10.2604	10.05720	10.31763	14
47	9.6805[illegible]	9.94272	9.73987	10.26013	10.05727	10.31740	13
48	9.68282	9.94265	9.74016	10.25983	10.05734	10.31717	12
49	9.68305	9.94258	9.74046	10.25953	10.05741	10.31694	11
50	9.68328	9.94251	9.74076	10.25923	10.05748	10.31671	10
51	9.68351	9.94244	9.74106	10.25893	10.05755	10.31648	9
52	9.68374	9.94237	9.74135	10.25863	10.05762	10.31625	8
53	9.68397	9.94230	9.74166	10.25833	10.05769	10.31602	7
54	9.68420	9.94223	9.74196	10.2580[illegible]	10.05776	10.31579	6
55	9.68443	9.94216	9.74220	10.2577[illegible]	10.05783	10.31557	5
56	9.68465	9.94209	9.74255	10.25744	10.05790	10.31534	4
57	9.68488	9.94202	9.74285	10.25714	10.05797	10.31511	3
58	9.68511	9.94195	9.74315	10.25684	10.05804	10.31488	2
59	69.8534	9.94188	9.74345	10.25654	10.05811	10.31465	1
60	60.8557	9.94181	9.74375	10.25624	10.05818	10.31442	0
		Sine		Tang.		Secant	M.

61 *Degrees.*

29 Degrees.							
M	Sine		Tang.		Secant		
0	9.68557	9.94181	9.74375	10.25024	10.05818	10.31442	60
1	9.68579	9.94174	9.74405	10.25595	10.05825	10.31420	59
2	9.68602	9.94167	9.74434	10.25565	10.05832	10.31397	58
3	9.68625	9.94160	9.74464	10.25535	10.05839	10.31374	57
4	9.68648	9.94152	9.74494	10.25505	10.05846	10.31351	56
5	9.68670	9.94146	9.74524	10.25476	10.05853	10.31329	55
6	9.68693	9.94139	9.74553	10.25446	10.05860	10.31306	54
7	9.68716	9.94132	9.74583	10.25416	10.05867	10.31283	53
8	9.68738	9.94125	9.74613	10.25386	10.05874	10.31261	52
9	9.68761	9.94118	9.74642	10.25357	10.05881	10.31238	51
10	9.68784	9.94111	9.74672	10.25327	10.05888	10.31215	50
11	9.68806	9.94104	9.74702	10.25297	10.05895	10.31193	49
12	9.68829	9.94097	9.74731	10.25268	10.05902	10.31170	48
13	9.68852	9.94090	9.74761	10.25238	10.05909	10.31147	47
14	9.68874	9.94082	9.74791	10.25208	10.05016	10.31125	46
15	9.68897	9.94075	9.74820	10.25179	10.05923	10.31102	45
16	9.6891	9.94069	9.74850	10.25149	10.05930	10.31080	44
17	9.68942	9.94062	9.74880	10.25119	10.05937	10.31057	43
18	9.68964	9.94055	9.74909	10.25090	10.05944	10.31035	42
19	9.68987	9.94043	9.74939	10.25060	10.05952	10.31012	41
20	9.6900	9.94040	9.749 8	10.25031	10.05959	10.3099	40
21	9.69032	9.94033	9.74998	10.25001	10.05966	10.30967	39
22	9.69054	9.94026	9.75028	10.24971	10.05973	10.30945	38
23	9.69077	9.94019	9.75057	10.24942	10.05980	10.30922	37
24	9.69099	9.94012	9.75087	10.24912	10.05987	10.3090	36
25	9.69122	9.94005	9.75117	10.24883	10.05994	10.30877	35
26	9.69144	9.93998	9.75146	10.24853	10.06001	10.30855	34
27	9.69166	9.93991	9.75175	10.24824	10.06008	10.30833	33
28	9.69189	9.93984	9.75205	10.24794	10.06016	10.30810	32
29	9.69211	9.93976	9.75235	10.24765	10.06023	10.30788	31
30	9.69233	9.93969	9.75264	10.24735	10.06030	10.30766	30
		Sine		Tang.		Secant	M.
60 Degrees.							

29 *Degrees.*

M.	Sine		Tan.		Secant.		
30	9.69234	9.93969	9.75264	10.24735	0.06030	10.30766	30
31	9.69256	9.93962	9.75293	10.24706	10.06037	10.30734	29
32	9.69278	9.93955	9.75323	10.24676	10.06044	10.30721	28
33	9.69300	9.93948	9.75352	10.24647	10.06051	10.30699	27
34	9.69323	9.93949	9.75382	10.24618	10.06058	10.30676	26
35	9.69345	9.93933	9.75411	10.24588	10.06066	10.30654	25
36	9.69367	9.93926	9.75440	10.24559	10.06073	10.30632	24
37	9.69389	9.93919	9.75470	10.24529	10.06080	10.30610	23
38	9.69412	9.93912	9.75499	10.24501	10.06087	10.30588	22
39	9.69434	9.93905	9.75529	10.24470	10.06094	10.30565	21
40	9.69456	9.93898	9.75558	10.24441	10.06102	10.30543	20
41	9.69478	9.9389	9.75587	10.24412	10.06109	10.30521	19
42	9.69500	9.93883	9.75617	10.24382	10.06116	10.30499	18
43	9.69522	9.93876	9.75646	10.24353	10.0 123	10.30477	17
44	9.69545	9.93869	9.75675	10.24324	10.06130	10.30455	16
45	9.69567	9.93861	9.75705	10.24294	10.06138	10.30432	15
46	9.69589	9.93854	9.75734	10.24265	10.06145	10.30410	14
47	9.69611	9.93847	9.75763	10.24236	10.06152	10.30388	13
48	9.69633	9.93840	9.75793	10.24206	10.06159	10.30366	12
49	9.69655	9.93833	9.75822	10.24177	10.06167	10.30244	11
50	9.69677	9.93825	9.75851	10.24148	10.06174	10.30222	10
51	9.69699	9.93818	9.75881	10.24119	10.06181	10.30300	9
52	9.69721	9.93811	9.75910	10.24089	10.06188	10.30278	8
53	9.69743	9.93804	9.75939	10.24060	10.06196	10.30256	7
54	9.69765	9.93796	9.75968	10.24031	10.06203	10.30234	6
55	9.69787	9.93789	9.75997	10.24002	10.06210	10.30212	5
56	9.69809	9.93782	9.76027	10.23972	10.06217	10.30190	4
57	9.69831	9.93774	9.76056	10.23943	10.06225	10.30168	3
58	9.69853	9.93767	9.76085	10.23914	10.06232	10.30146	2
59	9.69875	9.93760	9.76114	10.23885	10.06239	10.30124	1
60	9.69897	9.93753	9.76143	10.23856	10.06245	10.30102	0
		Sine.	Tangent			Secant.	M

60 *Degrees.*

30 *Degrees.*

M.	Sine		Tang.		Secant.		
0	9.69897	9.93753	9.76143	10.23856	10.06246	10.30103	60
1	9.69918	9.93745	9.76173	10.23826	10.06254	10.30081	59
2	9.69940	9.93738	9.76202	10.23797	10.06261	10.30059	58
3	9.69962	9.93731	9.76231	10.23768	10.06268	10.30037	57
4	9.69984	9.93723	9.76260	10.23739	10.06276	10.30015	56
5	9.70006	9.93716	9.76289	10.23710	10.06283	10.29993	55
6	9.70028	9.93709	9.76318	10.23681	10.06290	10.2[illegible]972	54
7	9.70049	9.93701	9.76347	10.23652	10.06298	10.29950	53
8	9.70071	9.93694	9.76377	10.23623	10.06305	10.29928	52
9	9.70093	9.93687	9.76406	10.23593	10.06312	10.29906	51
10	9.70115	9.93679	9.76435	10.23564	10.06330	10.29884	50
11	9.70136	9.93672	9.76464	10.23535	10.0632[illegible]	10.29862	49
12	9.70158	9.93665	9.76493	10.23506	10.06334	10.29841	48
13	9.70180	9.93657	9.76522	10.23477	10.06342	10.29819	47
14	9.70201	9.93650	9.76551	10.23448	10.06349	10.29798	46
15	9.70223	9.93643	9.76580	10.23419	10.06356	10.29776	45
16	9.70245	9.93635	9.76609	10.23390	10.06364	10.29754	44
17	9.70266	9.93628	9.76638	10.23361	10.06371	10.29733	43
18	9.70288	9.93621	9.76667	10.23332	10.06379	10.29711	42
19	9.70310	9.93613	9.76696	10.23303	10.06386	10.29689	41
20	9.70331	9.93606	9.76725	10.23274	10.06393	10.29668	40
21	9.70353	9.93598	9.76754	10.23245	10.06401	10.29646	39
22	9.70374	9.93591	9.76783	10.23216	10.06408	10.29624	38
23	9.70396	9.93584	9.76812	10.2318[illegible]	10.06416	10.29603	37
24	9.70417	9.93576	9.76841	10.22158	10.06423	10.29582	36
25	9.70439	9.93569	9.76870	10.23129	10.06430	10.2[illegible]56	35
26	[illegible]	9.93561	9.76899	10.23100	10.06438	10.29539	34
27	9.70[illegible]	9.93554	9.76928	10.23071	10.06445	10.29517	33
28	9.70[illegible]	9.93546	9.76957	10.23042	10.06453	10.29496	32
29	9.7052[illegible]	9.93539	9.76985	10.23014	10.06460	10.29475	31
30	9.70546	9.93532	9.77014	10.22985	10.06468	10.29453	30
		Sine.		Tangent		Secant.	

59 *Degrees.*

30 Degrees.							
M.	Sine.		Tang.		Secant		
30	9.70546	9.93532	9.77014	10.22985	10.06468	10.29453	30
31	9.70568	9.93525	9.77043	10.22956	10.06475	10.29431	29
32	9.70589	9.93517	9.77072	10.22927	10.06482	10.29410	28
33	9.70611	9.93509	9.77101	10.22898	10.06490	10.29388	27
34	9.70632	9.93502	9.77130	10.22869	10.06497	10.29367	26
35	9.70653	9.93494	9.77159	10.22840	10.06505	10.29346	25
36	9.70675	9.93487	.77188	10.22812	10.06512	10.29324	24
37	9.70696	9.93479	.77216	10.22783	10.06520	10.29303	23
38	9.70718	9.93472	.77245	10.22754	10.06527	10.29282	22
39	9.70739	9.93465	.77274	10.22725	10.06535	10.29260	21
40	9.70760	9.93457	9.77303	10.22696	10.06542	10.29239	20
41	9.70781	9.93449	9.77332	10.22667	10.06550	10.29218	19
42	9.70803	9.93442	9.77360	10.22639	10.06557	10.29196	18
43	9.70824	9.93434	.77389	10.22610	10.06565	10.29175	17
44	9.70845	9.93427	9.77418	10.22581	10.06572	10.29154	16
45	9.70867	9.93419	.77447	10.22552	10.06580	10.29133	15
46	9.70888	9.93412	9.77475	10.22523	10.06587	10.29111	14
47	9.70909	9.93404	.77504	10.22495	10.06595	10.29090	13
48	9.70930	9.93397	9.77533	10.22466	10.06602	10.29069	12
49	9.70951	9.93389	9.77562	10.22437	10.06610	10.29048	11
50	9.70973	9.93382	9.77590	10.22409	10.06617	10.29027	10
51	9.70994	9.93374	9.77619	10.22380	10.06625	10.29005	9
52	9.71015	9.93367	9.77648	10.22351	10.06632	10.2898	8
53	9.71036	9.93359	9.77676	10.22323	10.06640	10.28963	7
54	9.71057	9.93352	9.77705	10.22294	10.06648	10.28942	6
55	9.71078	9.93344	.77734	10.22265	10.06655	10.28921	5
56	9.71099	9.93336	9.77762	10.22237	10.06663	10.28900	4
57	9.71120	9.93329	9.77791	10.22208	10.06670	10.28879	3
58	9.71141	9.93321	9.77820	10.22179	10.06678	10.28858	2
59	9.71162	9.93314	9.77848	10.22151	10.06685	10.28837	1
60	9.71183	9.93306	9.77877	10.22122	10.06693	10.28816	0
		Sine		Tang.		Secant.	M.
59 Degrees.							

31 *Degrees.*

M.	Sine.		Tang.		Secant		
0	9.71183	9.93306	9.77877	10.22122	10.06693	10.28816	60
1	9.71204	9.93299	9.77906	10.22094	10.06701	10.28795	59
2	9.71225	9.93291	9.77934	10.22065	10.06708	10.28774	58
3	9.71246	9.93283	9.77963	10.22036	10.06716	10.28753	57
4	9.71267	9.93276	9.77991	10.22008	10.06723	10.28732	56
5	9.71288	9.93268	9.78020	10.21979	10.06731	10.28711	55
6	9.71309	9.93260	9.78048	10.21951	10.06739	10.28690	54
7	9.71330	9.93253	9.78077	10.21922	10.06[illegible]46	10.28[illegible]6	53
8	9.71351	9.93245	9.78106	10.21894	10.06754	10.28648	52
9	9.71372	9.93238	9.78134	10.21865	10.06762	10.28627	51
10	9.71393	9.93230	9.78163	10.21836	10.0676[illegible]	10.28606	50
11	9.71414	9.93222	9.78191	10.21808	10.06777	10.28[illegible]85	49
12	9.71435	9.93215	9.78220	10.21779	10.06784	10.28564	48
13	9.71456	9.93207	.78248	10.21751	10.06792	10.28543	47
14	.71476	9.93199	9.78277	10.21722	10.06800	10.28523	46
15	9.71497	9.93192	9.78305	10.216[illegible]4	10.0680[illegible]	10.28502	45
16	9.71518	9.9318[illegible]	9.78334	10.21666	10.06815	10.28481	44
17	9.71539	9.93176	.78362	10.21637	10.06823	10.28460	43
18	9.71560	9.9316[illegible]	9.78391	10.21609	10.06830	10.28439	42
19	9.71580	9.93161	9.78419	10.21580	10.06838	10.28419	41
20	9.71601	9.93153	9.78447	10.21552	10.06846	10.28398	40
21	9.71622	9.93146	9.78476	10.21523	10.06853	10.28377	39
22	9.71643	9.93138	9.78504	10.21495	10.06861	10.28356	38
23	9.71663	9.[illegible]313[illegible]	9.78533	10.21466	10.0686[illegible]	10.28336	37
24	9.71684	[illegible].9312[illegible]	9.78[illegible]1	10.21438	10.06877	10.28315	36
25	9.71[illegible]0[illegible]	9.93115	.78590	10.21410	10.06884	10.28294	35
26	9.7[illegible]72[illegible]	9.93107	9.78618	10.21381	10.06892	10.28274	34
27	9.71746	9.9309[illegible]	.[illegible]8646	10.2135[illegible]	10.06900	10.28253	33
28	9.71767	9.93092	9.78675	10.21324	10.06907	10.28232	32
29	[illegible].71[illegible]87	[illegible].9308[illegible]	9.78703	10.2129[illegible]	10.06915	10.28212	31
30	9.718[illegible]8	9.9307[illegible]	.78731	10.2126[illegible]	10.06[illegible]23	[illegible].281[illegible]1	30
		Sine		Tang.		Secant	M.

58 *Degrees.*

31 Degrees.

M.	Sine		Tang.		Secant		
30	9.71808	9.93076	9.78731	10.21268	10.06923	10.28191	30
31	9.71829	9.93068	9.78760	10.2123	10.06931	10.28170	29
32	9.71849	9.93061	9.78788	10.21211	10.06938	10.28150	28
33	9.71870	9.9305	9.7881	10.21183	10.06946	10.28129	27
34	9.71890	9.93 45	9.78845	10.21154	10.06954	10.2810	26
35	9.71911	9.93037	.78873	10.21126	10.06962	10.28088	25
36	9.71932	9.93030	9.78901	10.21098	10.06970	10.28068	24
37	9.71952	9.93022	9.78930	10.21069	10.06977	10.28047	23
38	9.71973	9.93014	9.78958	10.21041	10.06985	10.28027	22
39	9.71993	9.93006	9.78986	10.21013	10.06993	10.28006	21
40	9.72014	9.92998	9.79015	10.20984	10.07001	10.27986	20
41	9.72034	9.92991	9.79043	10.20956	10.07008	10.2796.	19
42	9.72054	9.92983	9.79071	10.20928	10.07016	10.27945	18
43	9.72075	9.92975	9.79099	10.20900	10.07024	10.2792	17
44	9.72095	9.9296	9.79128	10.20871	10.07032	10.279 4	16
45	9.72116	9.92959	9.79156	10.20843	10.07040	10.27883	15
46	9.72136	9.92952	9.79184	10.20815	10.07047	10.27863	14
47	9.72157	9.9294.	9.79212	10.20787	10.07055	10.27843	13
48	9.72177	9.92936	9.79241	10.20759	10.07063	10.27822	12
49	9.7219	9.92928	9.79269	10.20730	10.0707	10.27802	11
50	9.72218	9.9292	9.79297	10.20702	10.07079	10.27781	10
51	9.72238	9.92912	9.79325	10.20674	10.07087	10.27761	9
52	9.72258	9.92905	9.79353	10.20646	10.07094	10.27741	8
53	9.72279	9.92897	9.79381	10.20618	10.07102	10.27720	7
54	9.72209	9.92889	9.79410	10.20589	10.07110	10.27700	6
55	9.72319	9.92881	9.79438	10.20561	10.07118	10.27680	5
56	9.72340	9.92873	9.79466	10.20533	10.07126	10.27660	4
57	9.72360	9.92865	9.79494	10.20505	10.07134	10.2763	3
58	9.72380	9.92857	9.7952	10.20477	10.07142	10.27619	2
59	9.72400	9.92849	9.79550	10.20449	10.07150	10.27599	1
60	9.72421	9.92842	9.79578	10.20421	10.07157	10.2757	0
		Sine		Tang.		Secant	M.

58 Degrees.

32 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.72421	9.92842	9. 9578	10.20421	10.07157	10.27579	60
1	9.72441	9.92834	9.79607	10.20393	10.07165	10.27558	59
2	9.72461	9.92826	9.79635	10.20364	10.07173	10.27538	58
3	9.72481	9.92818	9.79663	10.20335	10.07181	10.27518	57
4	9.72501	9.92810	9.79691	10.20308	10.0718	10.27498	56
5	9.72521	9.92802	9. 9719	10.20280	10.07197	10.27478	55
6	9.72542	9.92794	9.79747	10.20252	10.07205	10.27458	54
7	9.72562	9.92786	9.79775	10.20224	10.07213	10.27437	53
8	9.72582	9.92778	9.79803	10.20196	10.07221	10.27417	52
9	9.72602	9.92770	9.79831	10.20168	10.07229	10.27397	51
10	9.72622	9.92762	9.79859	10.20140	10.07237	10.27377	50
11	9.72642	9.92754	9.79887	10.20112	10.07245	10.27357	49
12	9.72642	9.92746	9.79915	10.20084	10.07253	10.27337	48
13	9.72682	9.92738	9.79943	10.20056	10.07261	10.27317	47
14	9.72702	9.92731	9.79071	10.20028	10.07269	10.27297	46
15	9.72722	9.92723	9.79999	10.20000	10.07276	10.27277	45
16	9.72742	9.92715	9.80027	10.19972	10.07284	10.27257	44
17	9.72762	9.92707	9.80055	10.19944	10.07292	10.27237	43
18	9.72782	9.92699	9.80083	10.19916	10.07300	10.27217	42
19	9.72802	9.92691	9.80111	10.19888	10.07308	10.27197	41
20	9.72822	9.92683	9.80139	10.19860	10.07316	10.27177	40
21	9.72842	9.92675	9.80167	10.19832	10.07324	10.27157	39
22	9.72862	9.92667	9.80195	10.19804	10.07332	10.27137	38
23	9.72882	9.92659	9.80223	10.19776	10.07340	10.27117	37
24	9.72902	9.93651	9.80251	10.19748	10.07348	10.27097	36
25	9.72922	9.92643	9.80279	10.19720	10.07356	10.27077	35
26	9.72942	9.92635	9.80307	10.19692	10.07364	10.27057	34
27	9.72962	9.92627	9.80335	10.19664	10.07373	10.27037	33
28	9.72982	9.92619	9.80363	10.19637	10.07381	10.27018	32
29	9.73001	9.92611	9.80390	10.19609	10.07389	10.26998	31
30	9.72721	9.92602	9.80418	10.19581	10.07397	10.26978	30
		Sine		Tang.		Secant	M.

57 *Degrees.*

32 *Degrees.*

M.	Sine.		Tang.		Secant		
30	9.73021	9.92602	9.80418	10.19581	10.07397	10.26978	30
31	9.73041	9.92594	9.80446	10.19553	10.07405	10.26958	29
32	9.73061	9.92586	9.80474	10.19525	10.07413	10.26938	28
33	9.73081	9.92578	9.80502	10.19497	10.07421	10.26918	27
34	9.73100	9.92570	9.80530	10.19469	10.07429	10.26899	26
35	9.73120	9.92562	9.80558	10.19442	10.07437	10.26879	25
36	9.73140	9.92554	9.80585	10.19414	10.07445	10.26859	24
37	9.73160	9.92546	9.80613	10.19386	10.07453	10.26839	23
38	9.73179	9.92538	9.80641	10.19358	10.07461	10.26820	22
39	9.73199	9.92530	9.80669	10.19330	10.07469	10.26800	21
40	9.73219	9.92522	9.80697	10.19302	10.07477	10.26780	20
41	9.73239	9.92514	9.80724	10.19275	10.07485	10.26760	19
42	9.73258	9.92505	9.80752	10.19247	10.07494	10.26741	18
43	9.73278	9.92497	9.80780	10.19219	10.07502	10.26721	17
44	9.73298	9.92489	9.80808	10.19191	10.07510	10.26702	16
45	9.73317	9.92481	.80836	10.19163	10.07518	10.26682	15
46	9.73337	9.92473	9.80863	10.19136	10.07526	10.26662	14
47	9.73356	9.92465	9.80891	10.19108	10.07534	10.26643	13
48	9.73376	9.92457	9.80919	10.19080	10.07542	10.26623	12
49	9.73396	9.92449	9.80947	10.19052	10.07550	10.26603	11
50	9.73415	9.92440	9.80974	10.19025	10.07559	10.26584	10
51	9.73435	9.92432	9.81002	10.18997	10.07567	10.26564	9
52	9.73454	9.92424	9.81030	10.18969	10.07575	10.26545	8
53	9.73474	9.92416	9.81058	10.18942	10.07583	10.26525	7
54	9.73493	9.92408	9.81085	10.18914	10.07591	10.26506	6
55	9.73513	9.92401	9.81113	10.18886	10.07599	10.26486	5
56	9.73533	9.92391	9.81141	10.18858	10.07608	10.26467	4
57	9.73552	9.92383	9.81163	10.18831	10.07616	10.26447	3
58	9.73571	9.92375	9.81195	10.18803	10.07624	10.26428	2
59	9.73591	9.92367	9.81224	10.18775	10.07632	10.26408	1
60	9.73610	9.92359	9.81251	10.18748	10.07640	10.26480	0
		Sine		Tang.		Secant.	M

57 *Degrees.*

33 Degrees.

	Sine		Tang.		Secant		
0	9.73611	9.92359	9.81251	10.1874	10.07640	10.26389	60
1	9.73630	9.92350	9.81279	10.1872	10.07649	10.26369	59
2	9.73649	9.92342	9.81307	10.1869	10.07657	10.25350	58
3	9.73669	9.92334	9.81334	10.1866	10.07665	10 25330	57
4	.73688	9.02326	9.81362	10.18638	10.07673	10.26311	56
5	9.73708	9.92318	9.81389	10.18610	10.07681	10.26292	55
6	9.73727	9.92309	9.81417	10.18583	10.07690	10.26272	54
7	9.73746	9.92301	9.81445	10.18555	10.07698	10.26253	53
8	9.73766	9.92293	9.81472	10.18527	10.07756	10.26233	52
9	9.73785	9.92285	9.81500	10.18499	10.07714	10.26214	51
10	9.73804	9.92276	9.81527	10.18472	10.07723	10.26195	50
11	9.73824	9.92268	9.81555	10.18443	10.07731	10.26175	49
12	9.73843	9.9226	9.81583	10.18416	10.07739	10.26156	48
13	9.73862	9.92252	.81611	10.18389	10.07747	10.26137	47
14	.73882	0.92243	9.81638	10.18361	10.07756	10.26118	46
15	9.73901	9.92235	9.81665	10.18334	10.07764	10.26098	45
16	9 73920	9.92227	9.81693	10.18306	10.07772	10.26079	44
17	9.73939	9.92210	9.81720	10.18279	10.07781	10.26060	43
18	9.73959	9.92210	9.81748	10.18251	10.07789	10.26041	42
19	9.73978	9.92202	9.81776	10.18222	10.07797	10.26021	41
20	9.73997	9.92194	9.81803	10.18196	10.07806	10.26002	40
21	9.74016	9 92185	9.81831	10.18169	10.07812	10.25983	39
22	9.74035	9.92177	9.81858	10.18141	10.07822	10.25964	38
23	9.74057	9.92169	9.81886	10.18114	10.07830	10.25944	37
24	9.74024	9.02160	9.81913	10.18086	10.07830	10.25925	36
25	9.74093	9.92152	9.81941	10.18059	10.07847	10.25906	35
26	9.74112	9.92144	.81968	10.1803	10.07855	10.25887	34
27	9.74131	9.92134	9.81995	10.18004	10.07864	10.25868	33
28	9.74150	9.92127	9.81023	10.17976	10.07872	10.25849	32
29	9.74169	9.92119	9.81050	10.17949	10.07881	10.25830	31
30	9.74188	9.92110	9.81078	10.17921	10.07880	10.25811	30
		Sine		Tang.		Secant.	M

56 Degrees.

33 *Degrees.*

M.	Sine		Tang.		Secant.		
30	9.74188	9.92117	9.82078	10.17921	10.0788[illegible]	10.25811	30
31	9.74208	9.92102	9.82105	10.17894	10.07897	10.25792	29
32	9.74227	9.92093	9.82133	10.17866	10.07906	10.25772	28
33	9.74246	9.92085	9.82160	10.1[illegible]836	10.07914	10.25753	27
34	9.7426[illegible]	9.92077	9.82188	10.17812	10.07922	10.25734	26
35	9.74284	9.92068	9.82215	10.17784	10.07931	10.25715	25
36	9.74303	9.92060	9.82242	10.17757	10.07939	10.25696	24
37	9.74322	9.92052	9.82270	10.17729	10.07948	10.25677	23
38	9.74341	9.92043	9.82297	10.17702	10.07956	10.25658	22
39	9.7426[illegible]	9.92035	9.82325	10.17764	10.07964	10.25639	21
40	9.74379	9.92026	9.82352	10.17647	10.07973	10.25620	20
41	9.74398	9.92018	9.82379	10.17620	10.07931	10.25601	19
42	9.74417	9.92009	9.82407	10.17592	10.07990	10.25582	18
43	9.74436	9.92001	9.82434	10.17565	10.07998	10.25563	17
44	9.74455	9.91993	9.82461	10.17528	10.089[illegible]6	10.25[illegible]54	16
45	9.74473	9.91984	9.82489	10.17510	10.08015	10.25526	15
46	9.74492	9.91976	9.82516	10.17483	10.08023	10.25507	14
47	9.74511	9.91967	9.82543	10.17456	10.08032	10.25488	13
48	9.74530	9.91959	9.82571	10.17428	10.08040	10.25469	12
49	9.74549	9.91950	9.82598	10.17401	10.08049	10.254[illegible]0	11
50	9.74568	9.91942	9.82625	10.17374	10.08057	10.2543[illegible]	10
51	9.74587	9.91933	9.82653	10.17346	10.08065	10.25412	9
52	9.74605	9.91925	9.82680	10.17319	10.08074	10.25394	8
53	9.74624	9.91916	9.82707	10.1729[illegible]	10.08083	10.25375	7
54	9.74643	9.91908	9.82735	10.1726[illegible]	10.08[illegible]	10.2[illegible]56	6
55	9.74662	9.91900	9.82762	10.17237	10.0810[illegible]	10.25337	5
56	9.74681	9.91891	9.82789	10.1721[illegible]	10.08108	10.25318	4
57	9.7469[illegible]	9.9188[illegible]	9.82817	10.1718[illegible]	10.08117	10.25300	3
58	9.7471[illegible]	9.91874	9.82844	10.1715[illegible]	10.08125	10.2528[illegible]	2
59	9.74737	9.91865	9.82871	10.17128	10.08134	10.2526[illegible]	1
60	9.747[illegible]	9.9185[illegible]	9.82898	10.17101	10.08142	10.25[illegible]	0
		Sine.		Tangent		Secant.	M.

56 *Degrees.*

34 *Degrees.*

M.	Sine		Tang.		Secant.		
0	9.74756	9.91857	9.82898	10.17101	10.08142	10.25243	60
1	9.74774	9.91848	9.82926	10.17074	10.08151	10.25225	59
2	9.74793	9.91840	9.82953	10.17046	10.08159	10.25206	58
3	9.74812	9.91831	9.82980	10.17019	10.08168	10.25187	57
4	9.74830	9.91823	9.83007	10.16992	10.08176	10.25169	56
5	9.74849	9.91814	9.83034	10.16965	10.08185	10.25150	55
6	9.74868	9.91806	9.83062	10.16937	10.08193	10.25131	54
7	9.74887	9.91797	9.83089	10.16910	10.08202	10.25113	53
8	9.74905	9.91789	9.83116	10.16883	10.08210	10.25094	52
9	9.74924	9.91780	9.83143	10.16856	10.08219	10.25076	51
10	9.74942	9.91771	9.83170	10.16829	10.08228	10.25057	50
11	9.74961	9.91763	9.83198	10.16801	10.08236	10.25038	49
12	9.74980	9.91754	9.83225	10.16774	10.08245	10.25019	48
13	9.74998	9.91746	9.83252	10.16747	10.08253	10.25001	47
14	9.75017	9.91737	9.83279	10.16720	10.08262	10.24982	46
15	9.75036	9.91729	9.83306	10.16693	10.08271	10.24964	45
16	9.75054	9.91720	9.83333	10.16666	10.08279	10.24945	44
17	9.75072	9.91711	9.83361	10.16638	10.08288	10.24927	43
18	9.75091	9.91703	9.83388	10.16611	10.08296	10.24908	42
19	9.75100	9.91694	9.83415	10.16584	10.08305	10.24890	41
20	9.75128	9.91685	9.83442	10.16557	10.08314	10.24871	40
21	9.75146	9.91677	9.83469	10.16530	10.08322	10.24853	39
22	9.75165	9.91668	9.83496	10.16503	10.08331	10.24834	38
23	9.75183	9.91660	9.83523	10.16476	10.08340	10.24816	37
24	9.75202	9.91651	9.83550	10.16449	10.08348	10.24797	36
25	9.75220	9.91642	9.83578	10.16422	10.08357	10.24779	35
26	9.75239	9.91634	9.83605	10.16394	10.08365	10.24760	34
27	9.75257	9.91625	9.83632	10.16367	10.08374	10.24742	33
28	9.75276	9.91616	9.83659	10.16340	10.08383	10.24724	32
29	9.75294	9.91608	9.83686	10.16313	10.08391	10.24705	31
30	9.75312	9.91699	9.83713	10.16286	10.08400	10.24687	30
		Sine.		Tangent.		Secant.	M.

55 *Degrees.*

34 *Degrees.*

M	Sine.		Tang.		Secant.		
30	9.75312	9.91599	9.83713	10.16280	10. 8400	10.24687	30
31	9.75331	9.91590	9.88740	10.16259	10.08409	10.24668	29
32	9.75349	9.91582	9.83767	10.16232	10.08418	10.24650	28
33	9.75367	9.91573	9.83794	10.16205	10.08426	10.24632	27
34	9.75386	9.91564	9.83821	10.16178	10.08435	10.24613	26
35	9.75404	9.91555	9.83848	10.16151	10.08444	10.24595	25
36	9.75422	9.91547	9.83875	10.16124	10.08452	10.24577	24
37	9.75441	9.91538	9.83902	10.16097	10.08461	10.24558	23
38	9.75459	9.91529	9.83929	10.16070	10.08470	10.24540	22
39	9.75477	9.91521	9.83956	10.16043	10.08479	10.24522	21
40	9.75496	9.91512	9.83983	10.16016	10.08487	10.24504	20
41	9.75514	9.91503	9.84010	10.15989	10.08496	10.24485	19
42	9.75532	9.91494	9.84037	10.15962	10.08505	10.24467	18
43	9.75550	9.91486	9.84064	10.15935	10.08514	10.24449	17
44	9.75569	9.91477	9.84091	10.15908	10.08522	10.24431	16
45	9.75587	9.91468	9.84118	10.15881	10.08531	10.24412	15
46	9.75605	9.91459	9.84145	10.15854	10.08540	10.24394	14
47	9.75623	9.91450	9.84172	10.15827	10.08549	10.24376	13
48	9.75641	9.91442	9.84199	10.15800	10.08557	10.24358	12
49	9.75660	9.91433	9.84226	10.15773	10.08566	10.24340	11
50	9.75678	9.91424	9.84253	10.15746	10.08575	10.24321	10
51	9.75696	9.91415	9.84280	10.15719	10.08584	10.24303	9
52	9.75714	9.91407	9.84307	10.15692	10.08593	10.24285	8
53	9.75732	9.91398	9.84334	10.15665	10.08601	10.24267	7
54	9.75750	9.91389	9.84361	10.15628	10.08610	10.24249	6
55	9.75768	9.91380	9.84388	10.1361	10.08619	10.24231	5
56	9.75786	9.91371	9.84415	10.15584	10.08628	10.24213	4
57	9.75804	9.91363	9.84442	10.15558	10.08637	10.74195	3
58	9.75823	9.91354	9.84468	10.15531	10.08645	10.24177	2
59	9.75841	9.91345	9.84495	10.15504	10.08654	10.24158	1
60	9.75859	9.91336	9.84522	10.15477	10.08663	10.24140	0
		Sine.		Tang.		Secant.	M

55 *Degrees.*

35 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.75859	9.91336	9.84522	10.15477	10.08633	10.24141	60
1	9.75877	9.91327	9.84549	10.15450	10.08672	10.24122	59
2	9.75895	9.91318	9.84576	10.15423	10.08681	10.24104	58
3	9.75913	9.91309	9.84603	10.15396	10.08690	10.24086	57
4	9.75921	9.91301	9.84630	10.15360	10.08699	10.24068	56
5	9.75949	9.91292	9.84657	10.15342	10.08707	10.24050	55
6	9.75967	9.91283	9.84683	10.15316	10.08716	10.2403[illegible]	54
7	9.75985	9.91274	9.84710	10.15289	10.08725	10.24014	53
8	9.76003	9.91265	9.84737	10.15262	10.08734	10.23996	52
9	9.76021	9.91256	9.84764	10.15235	10.08743	10.23978	51
10	9.76039	9.91247	9.84791	10.15208	10.08752	10.239[illegible]	50
11	9.76056	9.91238	9.84818	10.15181	10.08761	10.2394[illegible]	49
12	9.76074	9.9122[illegible]	9.84844	10.1515[illegible]	10.08770	10.2392[illegible]	48
13	9.76092	9.91221	9.84871	10.15128	10.08779	10.23907	47
14	9.76110	9.91212	9.84898	10.15101	10.08787	10.2388[illegible]	46
15	9.76128	9.91203	9.84925	10.15074	10.08790	10.23871	45
16	9.76146	9.91194	9.84952	10.15047	10.08805	10.23853	44
17	9.76164	9.91185	9.84979	10.1502[illegible]	10.08814	10.23835	43
18	9.76182	9.9117[illegible]	9.85905	10.14994	10.08823	10.2381[illegible]	42
19	9.76109	9.9116[illegible]	9.85032	10.14967	10.08832	10.23800	41
20	9.762[illegible]	9.91158	9.85059	10.14940	10.08841	10.23782	40
21	9.76235	9.91149	9.85086	10.14913	10.08850	10.23764	39
22	9.76253	9.91140	9.85112	10.14887	10.08859	10.23746	38
23	9.76271	9.91131	9.85139	10.14860	10.08868	10.23728	37
24	9.76288	9.91122	9.85166	10.14833	10.08877	10.23711	36
25	9.76306	9.91113	9.85193	10.14806	10.08886	10.2369[illegible]	35
26	9.76324	9.91104	9.85219	10.14780	10.08895	10.23675	34
27	9.76342	9.91095	9.85246	10.14753	10.08904	10.23657	33
28	9.76360	9.91087	9.85273	10.14726	10.08913	10.23640	32
29	9.76377	9.91076	9.85300	10.14699	10.08922	10.236[illegible]	31
30	9.76395	9.91068	9.85326	10.14673	10.08931	10.2360[illegible]	30
		Sine		Tang.		Secant	

54 *Degrees.*

35 Degrees.							
M.	Sine.		Tang.		Secant.		
30	9.76395	9.91068	9.85326	10.14673	10.08931	10.23604	30
31	9.76413	9.91059	9.85353	10.14646	10.08940	10.23586	29
32	9.76430	9.91050	9.85380	10.14619	10.08949	10.23569	28
33	9.76448	9.91041	9.85406	10.14593	10.08958	10.23551	27
34	9.76466	9.91032	9.85433	10.14566	10.08967	10.23533	26
35	9.76483	9.91023	9.85460	10.14539	10.08976	10.23516	25
36	9.76501	9.91014	9.85487	10.14513	10.08985	10.23498	24
37	9.76519	9.91005	9.85513	10.14486	10.08994	10.23480	23
38	9.76536	9.90996	9.85540	10.14459	10.09003	10.23463	22
39	9.76554	9.90987	9.85567	10.14432	10.09012	10.23445	21
40	9.76572	9.90978	9.85593	10.14400	10.09021	10.23428	20
41	9.76589	9.90969	9.85620	10.14379	10.09030	10.23410	19
42	9.76607	9.90960	9.85647	10.14352	10.09039	10.23392	18
43	9.76624	9.90951	9.85673	10.14326	10.09049	10.23375	17
44	9.76642	9.90941	9.85700	10.14299	10.09058	10.23357	16
45	9.76659	9.90932	9.85727	10.14273	10.09067	10.23340	15
46	9.76677	9.90923	9.85753	10.14246	10.09076	10.23322	14
47	9.76694	9.90914	9.85780	10.14219	10.09085	10.23305	13
48	9.76712	9.90905	9.85806	10.14193	10.09094	10.23287	12
49	9.76729	9.90896	9.85833	10.14166	10.09102	10.23270	11
50	9.76747	9.90887	9.85860	10.14139	10.09112	10.23252	10
51	9.76764	9.90878	9.85886	10.14113	10.09121	10.23235	9
52	9.76782	9.90869	9.85913	10.14086	10.09131	10.23217	8
53	9.76799	9.90859	9.85940	10.14060	10.09140	10.23200	7
54	9.76817	9.90850	9.85966	10.14033	10.09149	10.23182	6
55	9.76834	9.90841	9.85993	10.14006	10.09158	10.23165	5
56	9.76852	9.90832	9.86019	10.13980	10.09167	10.23147	4
57	9.76869	9.90823	9.86046	10.13953	10.09176	10.23130	3
58	9.76887	9.90814	9.86073	10.13927	10.09185	10.23112	2
59	9.76804	9.90804	9.86099	10.13900	10.09195	10.23095	1
60	9.76821	9.90795	9.86126	10.13873	10.09204	10.23078	0
		Sine.		Tang.		Secant.	M.
54 Degrees.							

36 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.76921	9.90795	9.85126	10.13873	10.09204	10.23078	60
1	9.76939	9.90786	9.86152	10.13847	10.09213	10.23060	59
2	9.76956	9.90777	9.86179	10.13820	10.09222	10.23043	58
3	9.76974	9.90768	9.86205	10.13794	10.09231	10.23026	57
4	9.76991	9.90759	9.86232	10.13767	10.09241	10.23008	56
5	9.77008	9.90749	9.86258	10.13741	10.09250	10.22991	55
6	9.77026	9.90740	9.86285	10.13714	10.09259	10.22974	54
7	9.77043	9.90731	9.86311	10.13688	10.09268	10.22956	53
8	9.77060	9.90722	9.86338	10.13661	10.09277	10.22939	52
9	9.77077	9.90712	9.86365	10.13625	10.09287	10.22922	51
10	9.77095	9.90703	9.86391	10.13608	10.09296	10.22904	50
11	9.77112	9.90694	9.86418	10.13582	10.09305	00.22887	49
12	9.77129	9.90685	9.86444	10.13555	10.09314	10.22870	48
13	9.77147	9.90676	9.86471	10.13528	10.09324	10.22852	47
14	9.77164	9.90666	9.86497	10.13502	10.09333	10.22835	46
15	9.77181	9.90657	9.86524	10.13476	10.09342	10.22818	45
16	9.77198	9.90648	9.86550	10.13449	10.09351	10.22801	44
17	9.77215	9.90638	9.86577	10.13423	10.09361	10.22784	43
18	9.77233	9.90629	9.86603	10.13396	10.09370	10.22766	42
19	9.77250	9.90620	9.86630	10.13370	10.09379	10.22749	41
20	9.77267	9.90611	9.86656	10.13343	10.09388	10.22732	40
21	9.77284	9.90601	9.86682	10.13317	10.09398	10.22715	39
22	9.77301	9.90592	9.86709	10.13290	10.09407	10.22698	38
23	9.77319	9.90583	9.86735	10.13264	10.09416	10.22681	37
24	9.77336	9.90573	9.86762	10.13237	10.09426	10.22663	36
25	9.77353	9.90564	9.86788	10.13211	10.09435	10.22646	35
26	9.77370	9.90555	9.86815	10.13184	10.09444	10.22629	34
27	9.7738[illegible]	9.90545	9.86841	10.13158	10.09454	10.22612	33
28	9.77404	9.90536	9.86868	10.13132	10.09463	10.22595	32
29	9.77421	9.90527	9.86894	10.13105	10.09472	10.22578	31
30	9.77438	9.90517	9.86920	10.13079	10.09482	10.22561	30
		Sine		Tang.		Secant.	

53 *Degrees.*

36 Degrees.

M.	Sine		Tang.		Secant		
30	9.77438	9.90517	9.86920	10.13079	10.09482	10.22561	30
31	9.77455	9.90508	9.85947	10.13053	10.09491	10.22544	29
32	9.77472	9.90409	9.86973	10.13026	10.09500	10.22527	28
33	9.77489	9.90489	9.86000	10.12999	10.09510	10.22510	27
34	9.77507	9.90480	9.86026	10.12974	10.09515	10.22493	26
35	9.77524	9.90471	9.87052	10.12947	10.09528	10.22476	25
36	9.77541	9.90461	9.87079	10.12920	10.09538	10.22459	24
37	9.77558	9.90452	9.87105	10.12894	10.09547	10.22442	23
38	9.77575	9.90442	9.87132	10.12867	10.09557	10.22425	22
39	9.77592	9.90433	9.87158	10.12841	10.09566	10.22408	21
40	9.77609	9.90424	9.87184	10.12815	10.09575	10.22391	20
41	9.77625	9.90414	9.87211	10.12788	10 09585	10.22374	19
42	9.77642	9.90405	9.87237	10.12762	10.09594	10.22357	18
43	9.77659	9.90395	9.87264	10.12736	10.09604	10.22340	17
44	9.77676	9.90386	9.87290	10.12709	10.09613	10.22323	16
45	9.77693	9.90377	9.87316	10.12683	10.09623	10.22306	15
46	9.77710	9.90367	9.87343	10.12657	10.09632	10.22289	14
47	9.77727	9.90358	9.87369	10.12630	10.09641	10.22272	13
48	9.77744	9.90348	9.87395	10.12604	10.09651	10.22255	12
49	9.77761	9.90339	9.87422	10.12578	10.09660	10.22238	11
50	9.77778	9.90329	9.87448	10.12551	10.09670	10.22221	10
51	9.77795	9.90320	9.87474	10.12525	10.09679	10.22205	9
52	9.77811	9.90310	9.87501	10.12499	10.09689	10.22188	8
53	9.77828	9.90301	9.87527	10.12472	10.09698	10.22171	7
54	9.77845	9.90291	9.87553	10.12446	10.09708	10.22154	6
55	9.77862	9.90282	9.87580	10.12420	10.09717	10.22137	5
56	9.77879	9.90272	9.87606	10.12393	10.09727	10.22120	4
57	9.77896	9.90263	9.87632	10.12367	10.09736	10.22104	3
58	9.77912	9.90253	9.87658	10.12341	10.09746	10.22087	2
59	9.77929	9.90243	9.87685	10.12314	10.09755	10.22070	1
60	9.77946	9.90234	9.87711	10.12288	10.09765	10.22052	0
		Sine		Tang.		Secant	M.

53 Degrees.

37 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.77946	9.90234	9.87711	10.12288	10.09765	10.22053	60
1	9.77973	9.90225	9.87737	10.12262	10.09774	10.22036	59
2	9.77979	9.90215	9.87764	10.12236	10.09784	10.22020	58
3	9.77996	9.90206	9.87790	10.12209	10.09793	10.22003	57
4	9.78013	9.90196	9.87816	10.12183	10.09803	10.21986	56
5	9.78030	9.90187	9.87842	10.12157	10.09812	10.21970	55
6	9.78046	9.90177	9.87869	10.12130	10.09822	10.21953	54
7	9.78063	9.90168	9.87895	10.12104	10.09831	10.21936	53
8	9.78080	9.90158	9.87921	10.12078	10.09841	10.21919	52
9	9.78096	9.90148	9.87947	10.12052	10.09851	10.21903	51
10	9.78113	9.90139	9.87974	10.12025	10.09800	10.21886	50
11	9.78130	9.90129	9.88000	10.11999	10.09870	10.21869	49
12	9.78146	9.90120	9.88026	10.11973	10.09879	10.21853	48
13	9.78163	9.90110	9.88052	10.11947	10.09889	10.21836	47
14	9.78180	9.90101	9.88079	10.11911	10.09899	10.21819	46
15	9.78196	9.90091	9.88105	10.11894	10.099[illegible]8	10.21803	45
16	9.78213	9.90081	9.88131	10.11868	10.09918	10.21786	44
17	9.78229	9.90072	9.88157	10.11842	10.09927	10.21770	43
18	9.78246	9.90062	9.88183	10.11816	10.09937	10.21753	42
19	9.78263	9.90052	9.88210	10.11789	10.09947	10.21737	41
20	9.78279	9.90043	9.88236	10.11703	10.09956	10.21720	40
21	9.78296	9.90033	9.88262	10.11737	10.09966	10.21703	39
22	9.78312	9.90024	9.88288	10.11711	10.09976	10.21687	38
23	9.78329	9.90014	9.88314	10.11685	10.09985	10.21670	37
24	9.78345	9.90004	9 88341	10.11659	10.09995	10.21654	36
25	9.78362	9.89995	9.88367	10.11632	10.10004	10.21637	35
26	9.78378	9.89985	9.88393	10.11606	10.10014	10.21621	34
27	9.78395	9.89975	9.88419	10.11580	10.10024	10.21604	33
28	9.78411	9.89966	9.88445	10.11554	10.10034	10.21588	32
29	9.78428	9.89956	9.88471	10.11528	10.10043	10.21571	31
30	9.78444	9.89946	9.88498	10.11502	10.10053	10.21555	30
		Sine		Tang.		Secant.	M.

52 *Degrees.*

37 *Degrees.*

M.	Sine.		Tang.		Secant		
30	9.78444	9.89946	9.88498	10.11501	10.10053	10.21555	30
31	9.78461	9.89937	9.88524	10.11475	10.10063	10.21538	29
32	9.78477	9.89927	9.88550	10.11449	10.10072	10.21522	28
33	9.78494	9.89917	9.88576	10.11423	10.10082	10.21505	27
34	9.78510	9.89907	9.88602	10.11397	10.10092	10.21489	26
35	9.78526	9.89898	9.88628	10.11371	10.10101	10.21473	25
36	9.78543	9.89888	9.88654	10.11345	10.10111	10.21456	24
37	9.78559	9.89878	9.88681	10.11318	10.10121	10.21440	23
38	9.78576	9.89868	9.88707	10.11292	10.10131	10.21423	22
39	9.78592	9.89859	9.88733	10.11266	10.10140	10.21407	21
40	9.78608	9.89849	9.88759	10.11240	10.10150	10.21391	20
41	9.78625	9.89839	9.88785	10.11214	10.10160	10.21374	19
42	9.78641	9.89829	9.88811	10.11188	10.10170	10.21358	18
43	9.78657	9.89820	9.88837	10.11162	10.10179	10.21342	17
44	9.78674	9.89810	9.88863	10.11136	10.10189	10.21325	16
45	9.78690	9.89800	9.88890	10.11110	10.10199	10.21309	15
46	9.78706	9.89790	9.88916	10.11083	10.10209	10.22293	14
47	9.78723	9.89781	9.88942	10.11057	10.10219	10.21276	13
48	9.78739	9.89771	9.88968	10.11031	10.10228	10.21260	12
49	9.78755	9.89761	9.88994	10.11005	10.10289	10.21244	11
50	9.78772	9.89751	9.89020	10.10979	10.10248	10.21228	10
51	9.78788	9.89741	9.89046	10.10953	10.10258	10.21211	9
52	9.78804	9.89732	9.89072	10.10927	10.10268	10.21195	8
53	9.78820	9.89722	9.89098	10.10901	10.10277	10.21179	7
54	9.78837	9.89712	9.89124	10.10875	10.10287	10.21163	6
55	9.78853	9.89702	9.89150	10.10849	10.10297	10.21146	5
56	9.78869	9.89692	9.89176	10.10823	10.10307	10.21130	4
57	9.78885	9.89682	9.89202	10.10797	10:10317	10.21114	3
58	9.78901	9.89672	9.89228	10.10771	10.10327	10.21098	2
59	9.78918	9.89663	9.89254	10.10745	10.10336	00.21082	1
60	9.78634	9.89653	9.89281	10.10719	10.10346	10.210[illegible]	0
		Sine		Tang.		Secant	Mi

52 *Degrees.*

38 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.78934	9.89653	9.89281	10.10719	10.10346	10.21065	60
1	9.78950	9.89643	9.89307	10.10693	10.10356	10.21049	59
2	9.78966	9.89633	9.89332	10.10666	10.10366	10.21033	58
3	9.78982	9.89623	9.89359	10.10640	10.10376	10.21017	57
4	9.78998	9.89613	9.89385	10.10614	10.10386	10.21001	56
5	9.79014	9.89603	9.89411	10.10588	10.10396	10.20985	55
6	9.79031	9.89593	9.89437	10.10562	10.10406	10.20969	54
7	9.79047	9.89584	9.89463	10.10536	10.10416	10.20952	53
8	9.79063	9.89574	9.89489	10.10510	10.10425	10.20936	52
9	9.79079	9.89564	9.89515	10.10484	10.10435	10.20920	51
10	9.79095	9.89554	9.89541	10.10458	10.10445	10.20904	50
11	9.79111	9.89544	9.89567	10.10432	10.10455	10.20888	49
12	9.79127	9.89534	9.89593	10.10406	10.10465	10.20872	48
13	9.79143	9.89524	9.89619	10.10380	10.10475	10.20856	47
14	9.79159	9.89514	9.89645	10.10354	10.10485	10.20840	46
15	9.79175	9.89504	9.89671	10.10328	10.10495	10.20824	45
16	9.79191	9.89494	9.89697	10.10302	10.10505	10.20808	44
17	9.79207	9.89484	9.89723	10.10276	10.10515	10.20792	43
18	9.79223	9.89474	9.89749	10.10250	10.10525	10.20776	42
19	9.79239	9.89463	9.89775	10.10224	10.10535	10.20760	41
20	9.79255	9.89454	9.89801	10.10199	10.10545	10.20744	40
21	9.79271	9.89444	9.89827	10.10173	10.10555	10.20728	39
22	9.79287	9.89434	9.89853	10.10147	10.10565	10.20712	38
23	9.79303	9.89424	9.89878	10.10121	10.10575	10.20696	37
24	9.79319	9.89414	9.89904	10.10095	10.10585	10.20680	36
25	9.79335	9.89404	9.89930	10.10069	10.10595	10.20664	35
26	9.79351	9.89394	9.89956	10.10043	10.10605	10.20648	34
27	9.79367	9.89384	9.89982	10.10017	10.10615	10.20632	33
28	9.79383	9.89374	9.80008	10.09991	10.10625	10.20616	32
29	9.79399	9.89364	9.80034	10.09965	10.10635	10.20600	31
30	9.79415	9.89354	9.80060	10.09939	10.10645	10.20585	30
		Sine		Tang		Secant	

51 *Degrees.*

38 Degrees.							
M.	Sine.		Tang.		Secant		
30	9.79415	9.89354	9.90060	10.09939	10.10645	10.20585	30
31	9.79430	9.89344	9.90086	10.09913	10.10655	10.20569	29
32	9.79446	9.89334	9.90112	10.09887	10.10665	10.20553	28
33	9.79462	9.89324	9.90138	10.09861	10.10675	10.20537	27
34	9.79478	9.89314	9.90164	10.09835	10.10685	10.20521	26
35	9.79494	9.89304	9.90190	10.09809	10.10695	10.20505	25
36	9.79510	9.89294	9.90216	10.09784	10.10706	10.20489	24
37	9.79525	9.89283	9.90241	10.09758	10.10716	10.20474	23
38	9.79541	9.89273	9.90267	10.09732	10.10726	10.20458	22
39	9.79557	9.89263	9.90293	10.09706	10.10736	10.20442	21
40	9.79573	9.89252	9.90319	10.09680	10.10746	10.20426	20
41	9.79589	9.89243	9.90345	10.09654	10.10756	10.20410	19
42	9.79604	9.89233	9.90371	10.09628	10.10766	10.20395	18
43	9.79620	9.89223	9.90397	10.09602	10 10776	10.20379	17
44	9.79636	9.89213	9.90323	10.09576	10.10786	10.20363	16
45	9.79652	9.89203	9.90449	10.09550	10.10797	10.20347	15
46	9.79667	9.89192	9.90475	10.09525	10.10807	10.20332	14
47	9.79683	9.89182	9.90500	10.09491	10.10817	10.20316	13
48	9.79699	9.89172	9.90526	10.09473	10.10827	10.20300	12
49	9.79715	9.89162	9.90552	10.09447	10.10837	10.20285	11
50	9.79730	9.89152	9.90578	10 09421	10.10847	10.20269	10
51	9.79746	9.89142	9.90604	10.09395	10.10858	10.20253	9
52	9.79762	9.89131	9.90630	10.09369	10.10868	10.20237	8
53	9.79777	9.89121	9.90656	10.09344	10.10878	10.20222	7
54	9.79798	9.89111	9.90681	10.09318	10.10888	10.20206	6
55	9.79809	9.89101	9.90707	10.09292	10.10898	10.20190	5
56	9.79824	9.89091	9.90733	10.09266	10.10908	10.20175	4
57	9.79840	9.89080	9.90759	10.09240	10:10919	10.20159	3
58	9.79856	9.89070	9.90785	10.09214	10.10929	10.20144	2
59	9.79871	9.89060	9.90811	10.09188	10.10939	00.20128	1
60	9.79887	9.89050	9.90836	10.09163	10.10949	10.20112	0
		Sine		Tang.		Secant	M.
51 Degrees.							

39 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.79887	9.89050	9.90836	10.09163	10.10949	10.20112	60
1	9.79902	9.89040	9.90862	10.09137	10.10960	10.20097	59
2	9.79918	9.89029	9.90888	10.09111	10.10970	10.20081	58
3	9.79933	9.89019	9.90914	10.09085	10.10980	10.20066	57
4	9.79949	9.89009	9.90040	10.09059	10.10990	10.20050	56
5	9.79965	9.88999	9.90966	10.09034	10.11001	10.20034	55
6	9.79980	9.88988	9.90991	10.09008	10.11011	10.20019	54
7	9.79996	9.88978	9.91017	10.08982	10.11021	10.20003	53
8	9.80011	9.88968	9.91043	10.08956	10.11031	10.19988	52
9	9.80027	9.88957	9.91069	10.08930	10.11042	10.19972	51
10	9.80042	9.88947	9.91095	10.08904	10.11052	10.19957	50
11	9.80058	9.88937	9.91120	10.08879	10.11062	10.19941	49
12	9.80073	9.88927	9.91145	10.08853	10.11072	10.19926	48
13	9.80089	9.88916	9.91172	10.08827	10.11083	10.19910	47
14	9.80104	9.88906	9.91193	10.08801	10.11093	10.19895	46
15	9.80120	9.88896	9.91224	10.08776	10.11103	10.19879	45
16	9.80135	9.88885	9.91249	10.08750	10.11114	10.19864	44
17	9.80151	9.88875	9.91275	10.08724	10.11124	10.19848	43
18	9.80166	9.88865	9.91301	10.08698	10.11134	10 19833	42
19	9.80181	9.88854	9.91327	10.08672	10.11149	10.19818	41
20	9.80197	9.88844	9.91352	10.08647	10.11155	10.19802	40
21	9.80212	9.88834	9.91378	10.08621	10.11165	10.19787	39
22	9.80228	9.88823	9.91404	10.08595	10.11176	10.19771	38
23	9.80243	9.88813	9.91430	10.08569	10.11186	10.19756	37
24	9.80258	9.88803	9.91456	10.08544	10.11197	10.19741	36
25	9.80274	9.88792	9.91481	10.08518	10.11207	10.19725	35
26	9.80289	9.88782	9.91507	10.08492	10.11217	10.19710	34
27	9.80305	9.88771	9.91533	10.08466	10.11228	10.19695	33
28	9.80320	9.88761	9.91559	10.08441	10.11238	10.19679	32
29	9.80335	9.88751	9.91584	10.08415	10.11249	10.19664	31
30	9.80351	9 88740	9.91510	10.08389	10.11259	10.19648	30
		Sine.		Tang.		Secant	

50 *Degrees.*

39 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.80351	9.88740	9.91610	10.08389	10.11259	10.19648	30
31	9.80366	9.88730	9.91636	10.08363	10.11269	10.19633	29
32	9.80381	9.88719	9.91661	10.08338	10.11280	10.19618	28
33	9.80397	9.88799	9.91687	10.08312	10.11290	10.19603	27
34	9.80412	9.88698	9.91713	10.08286	10.11301	10.19587	26
35	9.80427	9.88688	9.91739	10.08260	10.11311	10.19572	25
36	9.80442	9.88678	9.91764	10.08235	10.11322	10.19557	24
37	9.80458	9.88667	9.91790	10.08209	10.11332	10.19541	23
38	9.80473	9.88657	9.91816	10.08183	10.11342	10.19526	22
39	9.80488	9.88646	9.91842	10.08158	10.11353	10.19511	21
40	9.80503	9.88636	9.91867	10.08132	10.11363	10.19496	20
41	9.80519	9.88625	9.91893	10.08106	10.11374	10.19480	19
42	9.80534	9.88615	9.91919	10.08080	10.11384	10.19465	18
43	9.80549	9.88604	9.91944	10.08055	10.11395	10.19450	17
44	9.80564	9.88594	9.91970	10.08029	10.11405	10.19435	16
45	9.80579	9.88583	9.91996	10.08003	10.11416	10.19420	15
46	9.80595	9.88573	9.92021	10.07978	10.11426	10.19404	14
47	9.80610	9.88562	9.92047	10.07952	10.11437	10.19389	13
48	9.80625	9.88552	9.92073	10.07926	10.11447	10.19374	12
49	9.80640	9.88541	9.92099	10.07901	10.11458	10.19359	11
50	9.80655	9.88531	9.92124	10.07875	10.11468	10.19344	10
51	9.80670	9.88520	9.92150	10.07849	10.11479	10.19329	9
52	9.80686	9.88510	9.92176	10.07824	10.11490	10.19314	8
53	9.80701	9.88499	9.92201	10.07798	10.11500	10.19298	7
54	9.80716	9.88488	9.92227	10.07772	10.11511	10.19283	6
55	9.80731	9.88478	9.92253	10.07747	10.11521	10.19268	5
56	9.80745	9.88467	9.92278	10.07721	10.11532	10.19253	4
57	9.80761	9.88457	9.92304	10.07695	10.11542	10.19238	3
58	9.80776	9.88446	9.92330	10.07670	10.11553	10.19223	2
59	9.80791	9.88436	9.92355	10.07644	10.11564	10.19208	1
60	9.80806	9.88425	9.92381	10.07618	10.11574	10.19193	0
		Sine		Tang		Secan	M

50 *Degrees.*

40 Degrees.							
M.	Sine		Tang.		Secant		
0	9.80806	9.88425	9.92381	10.07618	10.11574	10.19193	60
1	9.80821	9.88414	9.92407	10.07593	10.11585	10.19178	59
2	9.80836	9.88404	9.92432	10.07567	10.1159	10.19163	58
3	9.80851	9.88393	9.92458	10.07541	10.11606	10.19148	57
4	9.80866	9.88382	9.92484	10.07516	10.11617	10.19132	56
5	9.80881	9.88372	9.92509	10.07490	10.11627	10.19118	55
6	9.80896	9.88361	9.92535	10.07464	10.11638	0.19103	54
7	9.80911	9.88351	9.92560	10.07436	10.1164	10.19088	53
8	9.80926	9.88340	9.92586	10.07413	10.1165	10.19073	52
9	9.80941	9.88320	9.92612	10.07387	10.11670	10.19058	51
10	9.80956	9.8831	9.92637	10.07362	10.1168	10.19043	50
11	9.80971	9.88308	9.92653	10.07336	10.11691	10.19028	49
12	9.80986	9.88297	9.92689	10.07311	10.11702	10.19013	48
13	9.81001	9.88286	9.92714	10.07285	10.11712	10.18998	47
14	9.81016	9.88275	9.92740	10.07250	10.11723	10.18983	46
15	9.81031	9.3826	9.92765	10.07234	10.11734	10.18968	45
16	9.81046	9.88255	9.92791	10.07208	10.11745	10.18953	44
17	9.81061	9.88243	9.92817	10.07182	10.11755	10.18938	43
18	9.81076	9.88233	9.92842	10.07157	10.11766	10.18923	42
19	9.81091	9.88222	9.92868	10.07131	10.1177	10.18908	41
20	9.81106	9.8821	9.92894	10.07106	10.11787	10.18893	40
21	9.81121	9.88201	9.92919	10.0708	10.11798	10.18879	39
22	9.81135	9.88190	9.92945	10.07054	10.1180	10.18864	38
23	9.8115	9.88179	9.92970	10.07029	10.11820	10.18849	37
24	9.81165	9.88169	9.92996	10.07003	10.1183	10.18834	36
25	9.8118	9.88158	9.93021	10.06978	10.11841	10.18819	35
26	9.81195	9.88147	9.93047	10.06952	10.11852	10.18804	34
27	9.81210	9.88136	9.93073	10.06926	10.1186	10.1879	33
28	9.81225	9.88126	9.93098	10.06901	10.11872	10.18775	32
29	9.81239	9.88115	9.93124	10.06875	10.11884	10.18760	31
30	9.81254	9.88104	9.93149	10.06850	10.1189	10.18745	30
		Sine		Tang		Secant	
49 Degrees.							

40 *Degrees.*

M	Sine.		Tang.		Secant		
30	9.81254	9.88104	9.93149	10.06850	10.11895	10.18745	30
31	9.81269	9.88093	9.93175	10.06824	10.11906	10.18730	29
32	9.81284	9.88083	9.93201	10.06798	10.11917	10.18716	28
33	9.81298	9.88072	9.93226	10.06773	10.11927	10.18701	27
34	9.81313	9.88061	9.93252	10.06747	10.11938	10.18686	26
35	9.81328	9.88050	9.93277	10.06722	10.11949	10.18671	25
36	9.81343	9.88039	9.93303	10.06696	10.11960	10.18657	24
37	9.81357	9.88028	9.93328	10.06671	10.11971	10.18642	23
38	9.81372	9.88018	9.93354	10.06645	10.11982	10.18627	22
39	9.81387	9.88007	9.92380	10.0662	10.11992	10.18612	21
40	9.81401	9.87996	9.93405	10.06594	10.12003	10.18598	20
41	9.81416	9.87985	9.93431	10.06568	10.12014	10.18583	19
42	9.81431	9.87974	9.93456	10.06543	10.12025	10.18568	18
43	9.81446	9.87963	9.93482	10.06517	10.12036	10.18554	17
44	9.81460	9.87952	9.93507	10.06492	10.12047	10.18539	16
45	9.81475	9.87942	9.93533	10.06466	10.12058	10.18524	15
46	9.81490	9.87931	9.93558	10.06441	10.12068	10.18510	14
47	9.81504	9.87920	9.93584	10.06415	10.12079	10.18495	13
48	9.81519	9.87909	9.93610	10.06390	10.12090	10.18480	12
49	9.81523	9.87898	9.93635	10.06364	10.12101	10.18466	11
50	9.81548	9.87887	9.93661	10.06338	10.12112	10.18451	10
51	9.81563	9.87876	9.93686	10.06313	10.12123	10.18436	9
52	9.81577	9.87865	9.93712	10.06287	10.12134	10.18422	8
53	9.81592	9.87854	9.93737	10.06262	10.12145	10.18407	7
54	9.81606	9.87843	9.93763	10.06236	10.12156	10.18393	6
55	9.81621	9.87832	9.93788	10.06211	10.12167	10.18378	5
56	9.81635	9.87821	9.93814	10.06185	10.12178	10.18363	4
57	9.81650	9.87810	9.93839	10.06160	10.12189	10.18349	3
58	9.81665	9.87799	9.93865	10.06134	10.12200	10.18334	2
59	9.81679	9.87789	9.93890	10.06109	10.12211	00.18320	1
60	9.81694	9.87778	9.93916	10.06083	10.12222	10.18305	0
		Sine		Tang.		Secant	M.

49 *Degrees.*

41 *Degrees.*

M	Sine.		Tang.		Secant		
0	9.81694	9.87778	9.93916	10.06083	10.12222	10.18305	60
1	9.81708	9.87767	9.93941	10.06058	10.12233	10.18291	59
2	9.81723	9.87756	9.93967	10.06032	10.12244	10.18276	58
3	9.81737	9.37745	9.93995	10.06007	10.12255	10.18262	57
4	9.81752	9.87734	9.94034	10.05981	10.12266	10.18247	56
5	9.81766	9.87723	9.94043	10.05956	10.12277	10.18233	55
6	9.81781	9.87712	9.94069	10.05930	10.12288	10.18218	54
7	9.81795	9.87701	9.94094	10.05905	10.12299	10.18204	53
8	9.81810	9.87689	9.94120	10.05879	10.12310	10.18189	52
9	9.81824	9.87678	9.94145	10.05854	10.12321	10.18175	51
10	9.81839	9.87667	9.94171	10.05828	10.12332	10.18160	50
11	9.81853	9.87656	9.94196	10.05803	10.12343	10.18146	49
12	9.81868	9.87645	9.94222	10.05777	10.12354	10.18131	48
13	9.81882	9.87634	9.94247	10.05752	10.12365	10.18117	47
14	9.81896	9.87623	9.94273	10.05726	10.12376	10.18103	46
15	9.81911	9.87612	9.94298	10.05701	10.12387	10.18088	45
16	9.81925	9.87510	9.94324	10.05675	10.12398	10.18074	44
17	9.81940	9.87590	9.94349	10.05650	10.12409	10.18059	43
18	9.81954	9.87579	9.94375	10.05624	10.12420	10.18045	42
19	9.81968	9.87568	9.94400	10.05599	10.12431	10.18031	41
20	9.81983	9.87557	9.94426	10.05573	10.12442	10.18016	40
21	9.81997	9.87545	9.94451	10.05548	10.12454	10.18002	39
22	9.82012	9.87534	9.94477	10.05522	10.12465	10.17988	38
23	9.82026	9.87523	9.94502	10.05497	10.12476	10.17973	37
24	9.82041	9.87512	9.94528	10.05471	10.12487	10.17959	36
25	9.82055	9.87501	9.94553	10.05446	10.12498	10.17945	35
26	9.82069	9.87490	9.94579	10.05421	10.12509	10.17930	34
27	9.82083	9.87479	9.94604	10.05395	10.12520	10.17916	33
28	9.82097	9.87467	9.94629	10.05370	10.12532	10.17902	32
29	9.82112	9.87456	9.94655	10.05344	10.12543	10.17887	31
30	9.82126	9.87445	9.91680	10.05319	10.12554	10.17873	30
		Sine		Tang.		Secant	

48 *Degrees.*

41 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.82126	9.87445	9.94680	10.05319	10.12554	10.17873	30
31	9.82140	9.87434	9.94706	10.05293	10.12565	10.1785	29
32	9.82155	9.87423	9.94731	10.05268	10.12576	10.17845	28
33	9.82169	9.87412	9.94757	10.05242	10.1258	10.17830	27
34	9.82183	9.87400	9.94782	10.05217	10.1259	10.1781	26
35	9.82197	9.87389	9.94808	10.05191	10.12610	10.17802	25
36	9.82212	9.87378	9.94833	10.05166	10.12621	10.17788	24
37	9.82226	9.87367	9.94859	10.05141	10.12632	10.17773	23
38	9.82240	9.87356	9.94884	10.05115	10.12644	10.17759	22
39	9.82254	9.87344	9.94909	10.05090	10.12655	10.17745	21
40	9.82268	9.87333	9.94935	10.05064	10.12660	10.17731	20
41	9.82283	9.87322	9.94960	10.05039	10.12677	10.17717	19
42	9.82297	9.87311	9.94986	10.05013	10.12690	10.17702	18
43	9.82311	9.87299	9.95011	10.04988	10.12700	10.17638	17
44	9.82325	9.87288	9.95037	10.04962	10.12711	10.17674	16
45	9.82339	9.87277	9.95062	10.04937	10.12722	10.17660	15
46	9.82353	9.87265	9.95087	10.04912	10.12734	10.17646	14
47	9.82368	9.87254	9.95113	10.04886	10.12745	10.17632	13
48	9.82382	9.87243	9.95138	10.04861	10.12756	10.17617	12
49	9.82396	9.87232	9.95164	10.04835	10.12767	10.17603	11
50	9.82410	9.87220	9.95189	10.04810	10.12779	10.17589	10
51	9.82424	9.87209	9.95215	10.04785	10.12790	10.17575	9
52	9.82438	9.87198	9.95240	10.04759	10.12801	10.17561	8
53	9.82452	9.87186	9.95265	10.04734	10.12813	10.17547	7
54	9.82466	9.87175	9.95291	10.04708	10.12824	10.17533	6
55	9.82480	9.87164	9.95316	10.04683	10.12835	10.17519	5
56	9.82494	9.87152	9.95342	10.04657	10.1284	10.17505	4
57	9.82509	9.87141	9.95367	10.04632	10.12858	10.17491	5
58	9.82523	9.87130	9.95392	10.04607	10.12869	10.17477	2
59	9.82537	9.87118	9.95418	10.04581	10.1288	10.17462	1
60	9.82551	9.87107	9.95443	10.04356	10.12892	10.17448	0
		Sine		Tang.		Secant	M.

48 *Degrees.*

42 *Degrees.*

M.	Sine		Tang.		Secant		
0	9.82551	9.87107	9.95443	10.04556	10.12892	10.17448	60
1	9.82565	9.87096	9.95469	10.04530	10.1290[illegible]	10.17434	59
2	9.82579	9.87084	9.95494	10.0450[illegible]	10.12915	10.17420	58
3	9.82593	9.87073	9.95519	10.04480	10.12926	10.17406	57
4	9.82607	9.87061	9.95545	10.04454	10.12938	10.17392	56
5	9.82621	9.87050	9.95570	10.04429	10.12949	10.17378	55
6	9.82635	9.87039	9.95596	10.04403	10.12901	10.17364	54
7	9.82649	9.87027	9.95621	10.04378	10.12972	10.1735[illegible]	53
8	9.82663	9.87016	9.95646	10.04353	10.12983	10.17337	52
9	9.82677	9.8[illegible]004	9.95672	10.04327	10.1299[illegible]	10.17323	51
10	9.82691	9.86993	9.95697	10.0[illegible]302	10.12006	10.17309	50
11	9.82704	9.86981	9.95723	10.04276	10.12018	10.17295	49
12	9.82718	9.86970	9.95748	10.04251	10.12029	10.17281	48
13	9.82732	9.86958	9.95773	10.04226	10.12041	10.17267	47
14	9.82746	9.86947	9.95799	10.04200	10.12052	10.17253	46
15	9.82760	9.86936	9.95824	10.04175	10.13064	10.17239	45
16	9.82774	9.86924	9.95850	10.04150	10.13075	10.17225	44
17	9.82788	9.86913	9.95875	10.04124	10.13087	10.17211	43
18	9.82802	9.86901	9.9590[illegible]	10.04099	10.13098	10.17197	42
19	9.82816	9.86890	9.95926	10.04073	10.1311[illegible]	10.17183	41
20	9.82830	9.86878	9.95951	10.04048	10.13121	10.17169	40
21	9.82843	9.86867	9.95977	10.04023	10.13133	10.17156	39
22	9.82857	9.86855	9.96002	10.0399[illegible]	10.13144	10.17142	38
23	9.82871	9.86844	9.96027	10.03972	10.1315[illegible]	10.17128	37
24	9.82885	9.86832	9.96053	10.03947	10.1316[illegible]	10.17114	36
25	9.82899	9.86820	9.96078	10.03921	10.13179	10.17100	35
26	9.82913	9.86809	9.96103	10.03896	10.13190	10.17086	34
27	9.82926	9.86797	9.9612[illegible]	10.03870	10.13202	10.17073	33
28	9.82940	9.86786	9.96154	10.03845	10.13213	10.17059	32
29	9.82954	9.86774	9.96179	10.03820	10.13225	10.17045	31
30	9.82968	9.86763	9.96204	10.03794	10.13236	10.17031	30
			Sine	T[illegible]	Tang.	Secant	M.

47 *Degrees.*

42 *Degrees.*

M.	Sine.		Tang.		Secant.		
30	9.82968	9.86763	9.96205	10. 3794	10.13256	10.17031	30
31	9.82982	9.86751	9.96230	10.03769	10.13248	10.17017	29
32	9.82995	9.86739	9.96256	10.03744	10.13260	10.17004	28
33	9.8300	9.86728	9.96281	10.03718	0.13271	10.16990	27
34	9.83023	9.86716	9.96306	10.03693	0.13283	10.26976	26
35	9.83037	9.86705	9.96332	10.03668	10.13294	10.16962	25
36	9.83050	9.86693	9.96357	10.03642	10.13306	10.16949	24
37	9.83064	9.86681	9.96382	10.03617	10.13318	10.16935	23
38	9.83078	9.86670	9.96408	10.03591	10.13329	10.16921	22
39	9.83092	9.86658	9.96433	10.03566	10.13341	10.16907	21
40	9.83105	9.86647	9.96458	10.03541	10.13352	10.16894	20
41	9.83119	9.86635	9.96484	10.03515	10.13364	10.16880	19
42	9.83133	9.86623	9.96509	10.03490	10.13376	10.16866	18
43	9.83146	9.86612	9.96534	10.03465	10.13388	10.16853	17
44	9.83160	9.86600	9.96560	10.03439	10.12399	10.16839	16
45	9.83174	9.86588	9.96585	10.03414	10.13411	10.16825	15
46	9.83187	9.86577	9.96610	10.03389	10.13423	10.16812	14
47	9.83201	9.86565	9.96636	10.03363	10.13434	10.16798	13
48	9.83215	9.86553	9.96661	10.03338	10.13446	10.16784	12
49	9.83228	9.86541	9.96686	10.03313	10.13458	10.16771	11
50	9.83242	9.86530	9.96712	10.03287	10.13469	10.16757	10
51	9.83256	9.86518	9.96737	10.03262	10.13481	10.16743	9
52	9.83269	9.86506	9.96762	10.03237	10.13493	10.16730	8
53	9.83283	9.86495	9.96788	10.03211	10.13505	10.16716	7
54	9.83297	9.86483	9.96813	10.03186	10.13516	10.16703	6
55	9.83310	9.86471	9.96838	10.03161	10.13528	10.16689	5
56	9.83324	9.86459	9.96864	10.03135	10.1354	10.15675	4
57	9.83337	9.86448	9.96889	10.03110	10.13551	10.16662	3
58	9.83351	9.86436	9.96915	10.03085	10.13563	10.16648	2
59	9.83364	9.86424	9.96940	10.03059	10.13575	10.16635	1
60	9.83378	9.86412	9.96965	10.03034	10.13587	10.16621	0
		Sine.		Tang.		Secant.	M.

47 *Degrees.*

43 *Degrees.*

M.	Sine.		Tang.		Secant.		
0	9.83378	9.86412	9.96965	10.03034	10.13587	10.16621	60
1	9.83391	9.86401	9.96990	10.03009	10.13599	10.16608	59
2	9.83405	9.86389	9.97016	10.02983	10.13610	10.16594	58
3	9.83418	9.86377	9.97041	10.02958	10.13622	10.16581	57
4	9.83432	9.86365	9.97066	10.02933	10.13634	10.16567	56
5	9.83446	9.86353	9.97092	10.02907	10.13646	10.16554	55
6	9.83459	9.86341	9.97117	10.02882	10.13658	10.16540	54
7	9.83473	9.86330	9.97142	10.02857	10.13669	10.16527	53
8	9.83486	9.86318	9.97168	10.02831	10.13681	10.16513	52
9	9.83499	9.86306	9.97193	10.02806	10.13693	10.16500	51
10	9.83513	9.86294	9.97218	10.02781	10.13705	10.16486	50
11	9.83526	9.86282	9.97244	10.02755	10.13717	10.16473	49
12	9.83540	9.86270	9.97269	10.02730	10.13729	10.16459	48
13	9.83553	9.86259	9.97294	10.02705	10.13741	10.16446	47
14	9.83567	9.86247	9.97320	10.02679	10.13752	10.16432	46
15	9.83580	9.86235	9.97345	10.02654	10.13764	10.16419	45
16	9.83594	9.86223	9.97370	10.02629	10.13776	10.16405	44
17	9.83607	9.86211	9.97396	10.02604	10.13788	10.16392	43
18	9.83620	9.86199	9.97421	10.02578	10.13800	10.16379	42
19	9.83634	9.86187	9.97446	10.02553	10.13812	10.16365	41
20	9.83647	9.86175	9.97471	10.02528	10.13824	10.16352	40
21	9.83661	9.86163	9.97497	10.02502	10.13836	10.16338	39
22	9.83674	9.86151	9.97522	10.02477	10.13848	10.16325	38
23	9.83687	9.86140	9.97547	10.02452	10.13860	10.16312	37
24	9.83701	9.86128	9.97573	10.02426	10.13872	10.16298	36
25	9.83714	9.86116	9.97598	10.02401	10.13883	10.16285	35
26	9.83737	9.86104	9.97623	10.02376	10.13895	10.16272	34
27	9.83741	9.86092	9.97649	10.02350	10.13907	10.16258	33
28	9.83754	9.86080	9.97674	10.02325	10.13919	10.16245	32
29	9.8376	9.86068	9.97699	10.02300	10.13931	10.16232	31
30	9.83781	9.86056	9.97725	10.02375	10.12943	10.16218	30
		Sine.		Tang.		Secant.	M.

46 *Degrees.*

43 *Degrees.*

M.	Sine		Tang.		Secant		
30	9.83781	9.86056	9.97725	10.02275	10.13943	10.16[illegible]	60
31	9.83794	9.86044	9.97750	10.02249	10.13955	10.16[illegible]05	59
32	9.83807	9.86032	9.97775	10.02224	10.13967	10.16[illegible]9	58
33	9.83821	9.86020	9.97800	10.02199	10.13979	10.16178	57
34	9.83834	9.86008	9.97826	10.02173	10.13991	10.16165	56
35	9.83847	9.85996	9.97851	10.02148	10.14003	10.16152	55
36	9.83860	9.85984	9.97876	10.02123	10.14015	10.16139	54
37	9.83874	9.85972	9.97902	10.02097	10.14027	10.16125	53
38	9.83887	9.85960	9.97927	10.02072	10.14039	10.16112	52
39	9.83900	9.85948	9.97952	10.02047	10.14052	10.16099	51
40	9.83914	9.85936	9.97978	10.02022	10.14064	10.16086	50
41	9.83927	9.85923	9.98003	10.01996	10.14076	10.16072	49
42	9.83940	9.85911	9.98028	10.01971	10.14088	10.16059	48
43	9.83953	9.85899	9.98053	10.01946	10.14100	10.16046	47
44	9.83966	9.85887	9.98079	10.01920	10.14112	10.16033	46
45	9.83980	9.85875	9.98104	10.01895	10.14124	10.16020	45
46	9.83993	9.85863	9.98129	10.01870	10.14136	10.16006	44
47	9.84006	9.85851	9.98155	10.01845	10.14148	10.15993	43
48	9.84019	9.85839	9.98180	10.01819	10.14160	10.15980	42
49	9.84032	9.85827	9.98205	10.01794	10.14172	10.15967	41
50	9.84046	9.85815	9.98230	10.01769	10.14184	10.15954	40
51	9.84059	9.85802	9.98256	10.01743	10.14197	10.15940	39
52	9.84072	9.85790	9.98281	10.01718	10.14209	10.15927	38
53	9.84085	9.85778	9.98306	10.01603	10.14221	10.15914	37
54	9.84098	9.85766	9.98332	10.01668	10.14233	10.15901	36
55	9.84111	9.85754	9.98357	10.01642	10.14245	10.15888	35
56	9.84124	9.85742	9.98382	10.01617	10.14257	10.15875	34
57	9.84137	9.85730	9.98407	10.01592	10.14270	10.15862	33
58	9.84150	9.85717	9.98433	10.01566	10.14282	10.15849	32
59	9.84164	9.85705	9.98458	10.01541	10.14294	10.15836	31
60	9.84177	9.85693	9.98483	10.01516	10.14306	10.15822	30
		Sine		Tang.		Secant.	M.

46 *Degrees.*

44 Degrees.

M.	Sine		Tang.		Secant		
0	9.84177	9.85693	9.98483	10.01516	10.14306	10.15822	60
1	9.84190	9.85681	9.98509	10.01491	10.14318	10.15809	59
2	9.84203	9.85669	9.98534	10.01465	10.14331	10.15796	58
3	9.84216	9.85656	9.98559	10.01440	10.14343	10.15783	57
4	9.84229	9.85644	9.98584	10.01415	10.14355	10.15770	56
5	9.84242	9.85632	9.98610	10.01389	10.14367	10.15757	55
6	9.84255	9.85620	9.98635	10.01364	10.14379	10.15744	54
7	9.84268	9.85607	9.98690	10.01339	10.14392	10.15731	53
8	9.84281	9.85595	9.98686	10.01314	10.14404	10.15718	52
9	9.84294	9.85583	9.98711	10.01288	10.14416	10.15705	51
10	9.84307	9.85571	9.98736	10.01263	10.14428	10.15692	50
11	9.84320	9.85558	9.98761	10.01238	10.14441	10.15679	49
12	9.84333	9.85546	9.98787	10.01212	10.14453	10.15666	48
13	9.84346	9.85534	9.98812	10.01187	10.14465	10.15653	47
14	9.84359	9.85521	9.98837	10.01162	10.14478	10.15640	46
15	9.84372	9.85509	9.98862	10.01137	10.14490	10.15627	45
16	9.84385	9.85497	9.98888	10.01111	10.14502	10.15614	44
17	9.84398	9.85485	9.98913	10.01086	10.14515	10.15601	43
18	9.84411	9.85472	9.98938	10.01061	10.14527	10.15588	42
19	9.84424	9.85460	9.98964	10.01036	10.14539	10.15575	41
20	9.84437	9.85448	9.98989	10.01010	10.14552	10.15562	40
21	9.84450	9.85435	9.99014	10.00985	10.14564	10.15549	39
22	9.84463	9.85423	9.99039	10.00960	10.14576	10.15535	38
23	9.84476	9.85410	9.99065	10.00934	10.14589	10.15524	37
24	9.84488	9.85308	9.99090	10.00909	10.14601	10.15511	36
25	9.84501	9.85386	9.99115	10.00884	10.14613	10.15498	35
26	9.84514	9.85373	9.99140	10.00859	10.14626	10.15485	34
27	9.84527	9.85361	9.99166	10.00833	10.14638	10.15472	33
28	9.84540	9.85340	9.99191	10.00808	10.14651	10.15459	32
29	9.84553	9.85336	9.99216	10.00783	10.14663	10.15446	31
30	9.84566	9.85324	9.99242	10.00758	10.14675	10.15433	30
		Sine		Tang.		Secant	M.

45 Degrees.

44 *Degrees.*

M.	Sine		Tang.		Secant.		
30	9.84566	9.85324	9.99242	10 00758	10.14675	10.15433	30
31	9.84579	9.85311	9.99267	10.00732	10.14688	10.15421	29
32	9 84591	9.85299	9.99291	10.00707	10.14706	10.15408	28
33	9.84604	9 85286	9.99317	10.00682	10.14713	10.15395	27
34	9.84617	9.85274	9.99343	10.00656	10.14725	10.15382	26
35	9.84630	9.85262	9.99368	10.00631	10.14738	10.15369	25
36	9.8464[illegible]	9.85249	9.99393	10.00606	10.14750	10.15356	24
37	9.84656	9.85237	9.99413	10.00581	10.14762	10.15344	23
38	9.84668	9.85224	9.99444	10.00555	10.14775	10.15331	22
39	9.84681	9.85212	9.99469	10 00530	10.14787	10.15318	21
40	9.8469[illegible]	9.85199	9.99494	10.00505	10.14800	10.15305	20
41	9.84707	9.85187	9.99515	10.00480	10.14812	10.15292	19
42	9.84719	9.85174	9.99545	10.00454	10.14825	10.15280	18
43	9.84732	9.85162	9.99570	10.00429	10.14837	10.15267	17
44	9.8474[illegible]	9.85149	9.99595	10.00404	10.14850	10.15254	16
45	9.84758	9.85137	9.99621	10.00379	10.14862	10.15241	15
46	9.84770	9.85124	9.99646	10.00353	10.14875	10.15229	14
47	9.8478[illegible]	9.85112	9.99671	10.00328	10.14887	10.15216	13
48	9.84796	9.85099	9.99695	10.00303	10.14900	10.15203	12
49	9.84809	9.85087	9.99722	10 00277	10.14913	10.15190	11
50	9 84821	9.85074	9.99747	10 00252	10.14925	10.15178	10
51	9 84834	9.85051	9.99772	10.00227	10.14938	10.15165	9
52	9.84847	9.85049	9.99797	10.00202	10.14950	10.15152	8
53	9.84859	9.85036	9.99823	10.00176	10.14963	10 15140	7
54	9.84872	9.85024	9.99848	10.00151	10.14975	10.15127	6
55	9.84885	9.85011	9.99873	10.00125	10 14988	10.15114	5
56	9.84897	9.84999	9.99898	10.00101	10.15001	10.15102	4
57	9.84910	9.84986	9.99924	10.00075	10.15013	10.15089	3
58	9.84923	9.84973	9.99949	10.00050	10.15026	10.15076	2
59	9.84935	9.84961	9.99974	10.00025	10.15038	10.15064	1
60	9.84948	9.84948	1.00000	10.00000	10.15051	10.15051	0
		Sine.		Tangent.		Secant.	M.

56 *Degrees.*

A TABLE OF *LOGARITHM NUMBERS*,

From One to a Thousand:

WHEREBY

The *Logarithm* of any Number under 1000 may be readily diſcovered.

N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.00000	41	1.61278	81	1.90848	121	2.08278
2	0.30103	42	1.62324	82	1.91381	122	2.08635
3	0.47712	43	1.63346	83	1.91907	123	2.08990
4	0.60206	44	1.64345	84	1.92427	124	2.09342
5	0.69897	45	1.65321	85	1.92941	125	2.09691
6	0.77815	46	1.66275	86	1.93449	126	2.10037
7	0.84509	47	1.67209	87	1.93951	127	2.10380
8	0.90309	48	1.68124	88	1.94448	128	2.10720
9	0.95424	49	1.69029	89	1.94939	129	2.11058
10	1.00000	50	1.69897	90	1.95424	130	2.11394
11	1.04139	51	1.70757	91	1.95904	131	2.11727
12	1.07918	52	1.71600	92	1.96378	132	2.12057
13	1.11394	53	1.72427	93	1.96848	133	2.12385
14	1.14612	54	1.73239	94	1.97312	134	2.12710
15	1.17609	55	1.74036	95	1.97772	135	2.13033
16	1.20412	56	1.74818	96	1.98227	136	2.13353
17	1.23044	57	1.75587	97	1.98677	137	2.13672
18	1.25527	58	1.76342	98	1.99122	138	2.13987
19	1.27875	59	1.77085	99	1.99563	139	2.14301
20	1.30103	60	1.77815	100	2.00000	140	2.14612
21	1.32221	61	1.78533	101	2.00432	141	2.15921
22	1.34242	62	1.79239	102	2.00860	142	2.15228
23	1.36172	63	1.79934	103	2.01283	143	2.15533
24	1.38021	64	1.80618	104	2.01703	144	2.15836
25	1.39794	65	1.81291	105	2.02118	145	2.16136
26	1.41497	66	1.81954	106	2.02530	146	2.16435
27	1.43136	67	1.82607	107	2.02938	147	2.16731
28	1.44715	68	1.83250	108	2.03342	148	2.17026
29	1.46239	69	1.83884	109	2.03742	149	2.17318
30	1.47712	70	1.84509	110	2.04139	150	2.17609
31	1.49136	71	1.85125	111	2.04532	151	2.17897
32	1.50515	72	1.85733	112	2.04921	152	2.18184
33	1.51851	73	1.86332	113	2.05307	153	2.18469
34	1.53147	74	1.86923	114	2.05690	154	2.18752
35	1.54406	75	1.87506	115	2.06069	155	2.19033
36	1.55630	76	1.88081	116	2.06445	156	2.19312
37	1.56820	77	1.88649	117	2.06818	157	2.19589
38	1.57978	78	1.89209	118	2.07188	158	2.19865
39	1.59106	79	1.89762	119	2.07554	159	2.20139
40	1.60206	80	1.90309	120	2.07918	160	2.20411

N.	Log.	N.	Log.	N.	Log.	N.	Log.
151	2.23582	201	2.30419	241	2.38201	281	2.44870
162	2.20951	202	2.30535	242	2.38381	282	2.45024
163	2.21218	203	2.30749	243	2.38560	283	2.45178
164	2.21484	204	2.30963	244	2.38738	284	2.45331
165	2.21748	205	2.31175	245	2.38916	285	2.45584
166	2.22010	206	2.31386	246	2.39093	285	2.45636
167	2.22271	207	2.31597	247	2.39269	287	2.45788
168	2.22530	208	2.31806	248	2.39445	288	2.45939
169	2.22788	209	2.32014	249	2.39619	289	2.46089
170	2.23044	210	2.32221	250	2.39794	290	2.46239
171	2.23299	211	2.32428	251	2.39967	291	2.46389
172	2.23552	212	2.32633	252	2.40130	292	2.46538
173	2.23804	213	2.32837	253	2.40312	293	2.46686
174	2.24054	214	2.33041	254	2.40483	294	2.46834
175	2.24303	215	2.33243	255	2.40654	295	2.46982
176	2.24551	216	2.33445	256	2.40823	295	2.47129
177	2.24797	217	2.33645	257	2.40993	297	2.47275
178	2.25042	218	2.33845	258	2.41161	298	2.47421
179	2.25285	219	2.34044	259	2.41329	299	2.47567
180	2.25527	220	2.34242	260	2.41497	300	2.47712
181	2.25767	221	2.34439	261	2.41664	301	2.47856
182	2.26007	222	2.34635	252	2.41830	302	2.47800
183	2.26245	223	2.34830	263	2.41995	303	2.48144
184	2.26481	224	2.35024	264	2.42160	304	2.48287
185	2.26717	225	2.35218	265	2.42324	305	2.48429
186	2.26951	226	2.35410	266	2.42488	306	2.48572
187	2.27184	227	2.35602	267	2.42651	307	2.48713
188	2.27415	228	2.35793	268	2.42813	308	2.48855
189	2.27646	229	2.35983	269	2.42975	309	2.48995
190	2.27875	230	2.36172	270	2.42136	310	2.49136
191	2.28103	231	2.36361	271	2.43296	311	2.49276
192	2.28330	232	2.36548	272	2.43456	312	2.49415
193	2.28555	233	2.36735	273	2.43616	313	2.49554
194	2.28780	234	2.36921	274	2.43775	314	2.49692
195	2.29003	235	2.37106	275	2.43933	315	2.49831
196	2.29225	236	2.37291	276	2.44090	316	2.49968
197	2.29446	237	2.37474	277	2.44247	317	2.50105
198	2.29666	238	2.37657	278	2.44404	318	2.50242
199	2.29885	239	2.37839	279	2.44560	319	2.50379
200	2.30102	240	2.38021	280	2.44715	320	2.50514

N.	Log.	N.	Log.	N.	Log.	N.	Log.
321	2.50650	361	2.55750	401	2.60314	441	2.64443
322	2.50785	362	2.55870	402	2.60422	442	2.64542
323	2.50920	363	2.55990	403	2.60530	443	2.64640
324	2.51054	364	2.56110	404	2.60638	444	2.64738
325	2.51188	365	2.56229	405	2.60745	445	2.64836
326	2.51321	366	2.56348	406	2.60852	446	2.64933
327	2.51454	367	2.56466	407	2.60959	447	2.65030
328	2.51587	368	2.56584	408	2.61066	448	2.65127
329	2.51719	369	2.56702	409	2.61172	449	2.65224
330	2.51851	370	2.56820	410	2.61278	450	2.65321
331	2.51982	371	2.56937	411	2.61384	451	2.65417
332	2.52113	372	2.57054	412	2.61489	452	2.65513
333	2.52244	373	2.57170	413	2.61595	453	2.65609
334	2.52374	374	2.57287	414	2.61700	454	2.65705
335	2.52504	375	2.57403	415	2.61804	455	2.65801
336	2.52633	376	2.57518	416	2.61909	456	2.65896
337	2.52762	377	2.57634	417	2.620[illegible]3	457	2.65991
338	2.52891	378	2.57749	418	2.62117	458	2.56086
339	2.53019	379	2.57863	419	2.62221	459	2.66181
340	2.53147	380	2.57978	420	2.62324	460	2.66275
341	2.53275	381	2.58092	421	2.62428	461	2.66370
342	2.53402	382	2.58206	422	2.62531	452	2.66464
343	2.53529	383	2.58319	423	2.62634	463	2.66558
344	2.53655	384	2.58433	424	2.62736	464	2.66651
345	2.53781	385	2.58546	425	2.62838	465	2.66745
346	2.53907	386	2.58658	426	2.62940	466	2.66838
347	2.54032	387	2.58771	427	2.63042	467	2.66931
348	2.54157	388	2.58883	428	2.63144	468	2.67024
349	2.54282	389	2.58994	429	2.63245	469	2.67117
350	2.54400	390	2.59106	430	2.63346	470	2.67209
351	2.54530	391	2.59217	431	2.63447	471	2.67302
352	2.54654	392	2.59328	432	2.63548	472	2.67394
353	2.54777	393	2.59439	433	2.63648	473	2.67486
354	2.54900	394	2.59549	434	2.63748	474	2.67577
355	2.55022	395	2.59659	435	2.63848	475	2.67669
356	2.55144	396	2.59769	436	2.63948	476	2.67760
357	2.55266	397	2.59879	437	2.64048	477	2.67851
358	2.55388	398	2.59988	438	2.64147	478	2.67942
359	2.55509	399	2.60097	439	2.64246	479	2.68033
360	2.55630	400	2.60206	440	[illegible]	480	2.68124

N.	Log.	N.	Log.	N.	Log.	N.	Log.
481	2.68214	521	2 71683	561	2.74896	601	2.77887
432	2.68304	523	2.71767	562	2.74973	602	2.77959
483	2.68394	523	2.71850	563	2.75050	603	2.78031
484	2.68484	524	2.71933	564	2.75127	604	2.78103
485	2.68574	525	2.72015	565	2.75204	605	2.78175
486	2.68663	526	2.72098	566	2.75281	606	2.78247
487	2.68752	527	2.72181	567	2.75358	607	2.78318
488	2.68841	528	2.72263	568	2.75434	608	2.78390
489	2.68930	529	2.72345	569	2.75511	609	2 78461
490	2.69019	530	2.72427	570	2.75587	610	2.78532
491	2.69108	531	2.72509	571	2.75663	611	2.78604
492	2.69196	532	2.72591	572	2.75739	612	2.78675
493	2.69284	533	2.72672	573	2.75815	613	2.78746
494	2.69372	534	2.72754	574	2 75891	614	2.78816
495	2.69460	535	2.72835	575	2.75965	615	2.78887
496	2.69548	536	2.72916	576	2.76042	616	2.78958
497	2.69635	537	2.72997	577	2.76117	617	2 79028
498	2.69722	538	2.73078	578	2.76192	618	2.79098
499	2.69810	539	2.73158	579	2.76267	619	2.79169
500	2.69897	540	2.73239	580	2.76342	620	2.79239
501	2.69983	541	2.73319	581	2.76417	621	2.79309
502	2.70070	542	2.73399	582	2.76492	622	2.79379
503	2.70156	543	2.73479	583	2.76566	623	2.79448
504	2.70243	544	2.73559	584	2.76641	624	2.79518
505	2.70329	545	2.73639	585	2.76715	625	2.79588
506	2.70415	546	2.73719	586	2.76789	626	2.79657
507	2.70500	547	2.73798	587	2.76863	627	2.79726
508	2.70586	548	2.73878	588	2.76937	628	2.79795
509	2.70671	549	2.73957	589	2.77011	629	2.79865
510	2.70757	550	2.79036	590	2.77085	630	2.79934
511	2.70842	551	2.74115	591	2.77158	631	2.80002
512	2.70926	552	2.74193	592	2.77232	632	2.80071
513	2.71011	553	2.74272	593	2.77305	633	2.80140
514	2.71096	554	2.74350	594	2.77378	634	2.80208
515	2.71180	555	2.74429	595	2.77451	635	2.80277
516	2.71264	556	2.74507	596	2.77524	636	2.80345
517	2.71349	557	2.74585	597	2.77597	637	2.80413
518	2.71432	558	2.74663	598	2.77670	638	2.80482
519	2.71516	559	2.74741	599	2.77742	639	2.80550
520	2.71600	560	2.74818	600	2.77815	640	2.80617

N.	Log.	N.	Log.	N.	Log.	N.	Log.
641	2.80685	681	2.83314	721	2.85793	761	2.88138
642	2.80753	682	2.83378	722	2.85853	762	2.88195
643	2.80821	683	2.83442	723	2.85913	763	2.88252
644	2.80888	684	2.83505	724	2.85973	764	2.88309
645	2.80955	685	2.83567	725	2.86033	765	2.88366
646	2.81023	686	2.83632	726	2.86093	766	2.88422
647	2.81090	687	2.83695	727	2.86153	767	2.88479
648	2.81157	688	2.83758	728	2.86213	768	2.88536
649	2.81224	689	2.83821	729	2.86272	769	2.88592
650	2.81291	690	2.83884	730	2.86332	770	2.88649
651	2.81358	691	2.83947	731	2.86391	771	2.88705
652	2.81424	692	2.84010	732	2.86451	772	2.88761
653	2.81491	693	2.84073	733	2.86510	773	2.88817
654	2.81557	694	2.84135	734	2.86569	774	2.88874
655	2.81624	695	2.84198	735	2.86628	775	2.88930
656	2.81690	696	2.84260	736	2.86687	776	2.88986
657	2.81756	697	2.84323	737	2.86746	777	2.89042
658	2.81822	698	2.84385	738	2.86805	778	2.89097
659	2.81888	699	2.84447	739	2.86864	779	2.89153
660	2.81954	700	2.84509	740	2.86923	780	2.89209
661	2.82020	701	2.84571	741	2.86981	781	2.89265
662	2.82085	702	2.84633	742	2.87040	782	2.89320
663	2.82151	703	2.84695	743	2.87098	783	2.89376
664	2.82216	704	2.84757	744	2.87157	784	2.89431
665	2.82282	705	2.84818	745	2.87215	785	2.89486
666	2.82347	706	2.84880	746	2.87273	786	2.89542
667	2.82412	707	2.84941	747	2.87332	787	2.89597
668	2.82477	708	2.85003	748	2.87390	788	2.89652
669	2.82542	709	2.85064	749	2.87448	789	2.89707
670	2.82607	710	2.85125	750	2.87506	790	2.89762
671	2.82672	711	2.85186	751	2.87563	791	2.89817
672	2.82736	712	2.85247	752	2.87621	792	2.89872
673	2.82801	713	2.85308	753	2.87679	793	2.89927
674	2.82865	714	2.85369	754	2.87737	794	2.89982
675	2.82930	715	2.85420	755	2.87794	795	2.90036
676	2.82994	716	2.85491	756	2.87852	796	2.90091
677	2.83058	717	2.85551	757	2.87909	797	2.90145
678	2.83122	718	2.85612	758	2.87966	798	2.90200
679	2.83186	719	2.85672	759	2.88024	799	2.90254
680	2.83250	720	2.85733	760	2.88081	800	2.90308

N.	Log.	N.	Log.	N.	Log.	N.	Log.
801	2.90363	841	2.92479	881	2.94497	921	2.96425
802	2.90417	842	2.92531	882	2.94546	922	2.96473
803	2.90471	843	2.92582	883	2.94569	923	2.96520
804	2.90525	844	2.92634	884	2.94645	924	2.96567
805	2.90579	845	2.92685	885	2.94692	925	2.96614
806	2.90633	846	2.92737	886	2.94743	926	2.96661
807	2.90687	847	2.92788	887	2.94792	927	2.96707
808	2.90741	848	2.92839	888	2.94841	928	2.96754
809	2.90794	449	2.92890	889	2.94890	929	2.96801
810	2.90848	850	2.92941	890	2.94939	930	2.96848
811	2.90902	851	2.92992	891	2.94987	931	2.96894
812	2.90955	852	2.93043	892	2.95036	932	2.96941
813	2.91009	853	2.93094	893	2.95085	933	2.96988
814	2.91062	854	2.93145	894	2.95133	934	2.97034
815	2.91115	855	2.93196	895	2.95182	935	2.97081
816	2.91169	856	2.93247	896	2.95230	936	2.97127
817	2.91222	857	2.93298	897	2.95279	937	2.97173
818	2.91275	858	2.93348	898	2.95327	938	2.97220
819	2.91328	859	2.93399	899	2.95375	939	2.97266
820	2.91381	860	2.93449	900	2.95424	940	2.97312
821	2.91434	861	2.93500	901	2.95472	941	2.97358
822	2.91487	862	2.93550	902	2.95520	942	2.97405
823	2.91539	863	2.93601	903	2.95568	943	2.97451
824	2.91592	864	2.93651	904	2.95616	944	2.97497
825	2.91645	865	2.93701	905	2.95664	945	2.97543
826	2.91698	866	2.93751	906	2.95712	946	2.97589
827	2.91750	867	2.93801	907	2.95760	947	2.97634
828	2.91803	868	2.93851	908	2.95808	948	2.97680
829	2.91855	869	2.93901	909	2.95856	949	2.97726
830	2.91907	870	2.93951	910	2.95904	950	2.97772
831	2.91960	871	2.94001	911	2.95951	851	2.97818
832	2.92012	872	2.94051	912	2.95999	952	2.97863
833	2.92064	873	2.94101	913	2.96047	953	2.97909
834	2.92116	874	2.94151	914	2.96094	954	2.97954
835	2.92168	875	2.94000	915	2.96142	955	2.98000
836	2.92220	876	2.94250	916	2.96189	956	2.98045
837	2.92272	877	2.94299	917	2.96236	957	2.98091
838	2.92324	878	2.94349	918	2.96284	958	2.98136
839	2.92376	879	2.94398	919	2.96331	950	2.98181
840	2.92327	880	2.94448	920	2.96378	960	2.98227

N.	Log.	N.	Log.	N.	Log.	N.	Log.
961	2.98272	971	2.98721	981	2.99166	991	2.99607
962	2.98317	972	2.98766	982	2.99211	692	2.99651
963	2.98362	973	2.98811	983	2.99255	993	2.99694
964	2.98407	974	2.98855	984	2.99299	994	2.99738
965	2.98352	975	2.98900	985	2.99343	995	2.99782
966	2.98497	976	2.98944	986	2.99387	996	2.99825
967	2.98542	977	2.98989	987	2.99431	997	2.99869
968	2.98587	978	2.99033	988	2.99475	998	2.99913
966	2.98632	979	2.99078	989	2.99519	999	2.99956
970	2.98677	980	2.99122	990	2.99563	1000	3.00000

FINIS.

Tho: Luffkinn 96